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The works of the Lord are great, sought out of all them that have pleasure therein.—Ps. cxi, 2.

THE SIDEREAL MESSENGER.

APRIL, 1890.

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WM. W. PAYNE, EDITOR,

DIRECTOR OF CARLETON COLLEGE OBSERVATORY.

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XUM

THE SIDEREAL MESSENGER,

CONDUCTED BY WM. W. PAYNE.

DIRECTOR OF CARLETON COLLEGE OBSERVATORY, NORTHFIELD, MINN.

VOL. 9, No. 4. APRIL, 1890. WHOLE No. 84

THE U. S. N. ECLIPSE EXPEDITION TO WEST AFRICA.

FRANK H. BIGELOW.

FOR THE MESSENGER.

I am enabled, by the courtesy of Professor Todd, Director of this expedition, to give your readers a very brief sketch of the progress of events up to this date.

We sailed from New York on the morning of October 16th, in the U. S. S. Pensacola, Captain Arthur Yates commanding, hoping to arrive at St. Paul de Loanda by the 5th of December. It was necessary to take fresh supplies of coal at Horta in Fayal Island, at Porta Grande in San Vincent, at Free Town, Sierra Leone, and at Elminah on the Gold Coast, but we cast anchor before St. Paul on the evening of December 6th. A brief inquiry confirmed our supposition that Cape Ledo would be our proper eclipse station, as it was found that the railroad was incomplete into the interior of Loanda, that the Onanza river steamer had sailed two days before our arrival, besides which it would have been impracticable for us to handle our large supply of material apart from the assistance of the Pensacola. It should be stated frankly that the expedition is greatly indebted to the kindness of Captain Yates and all his officers for continuous and most efficient assistance in making our necessary preparations for the eclipse, which were incomplete by reason of the short time given us by the Government orders in which to make ready. The same good will and help remained with us as long as anything was needed to further the success of the expedition.

Cape Ledo has proved to be an excellent position, free from unhealthful influences and in fact wholly salubrious, as is seen by the circumstance that in eighteen days not a single person in the party and ship's company, numbering in all

about 430, has been ill in consequence of the effects of the climate. This shows that there are some healthy spots on the west coast of Africa. The camp was situated about 150 yards from the beach at the foot of two spurs of a bluff, ascending from east towards the west to an altitude of 100 feet. It included a large Ducker portable house for the polar axis, another for the 40-foot direct photoheliograph, two more for camp and storage houses, a Navy T. V. Transit house, and six tents for ten marines who acted as guard day and night. It may be mentioned that the natives visited us freely and appeared to be innocent and inoffensive people. The programme of work was that our headquarters were on ship board, whence large working parties were sent ashore as needed, the material and instruments landed as required, and in short the resources of the Pensacola were freely turned to our advantage by the courtesy of Captain Yates. The heavy work of constructing the piers and mounting the instruments was done in a few days, the preparation of the dark rooms and adjusting of the pieces of apparatus continued steadily till the beginning of the eclipse.

The apparatus was concentrated in two houses, one under the personal supervision of Professor Todd, the other being intrusted to Professor Bigelow. No attempt will be made to describe the instruments now, but it may be stated that Professor Todd had arranged on his large polar axis as many as twenty-four object glasses, including cameras of all descriptions, photographic, catoptric and dioptric telescopes, four spectroscopes and an actinic duplex telescope. These were all fitted up with pneumatic apparatus for moving the objective covers and changing the plates at the pre-arranged instants of exposure, one end of each telescope being within the dark room, having one side constructed of flexible material to permit following the diurnal motion of the sun. The performance of the polar axis, the Denver clock, and the new pneumatic system was eminently satisfactory. It shows that hundreds of exposures can be made at one station during the instants of totality with the same readiness that an operator has been accustomed to secure a score, and there is no reason why observers should not avail themselves of this method in the future. The forty-foot direct photoheliograph consisted of the Transit of Venus Nagasaki

lens, mounted in a steel spiral weld tube which was supported like a tripod one leg being converted into a clock by a large sand piston and cone. In the dark room was a revolving disk-reticle, with circular plates for ten exposures, controlled by an electric dial and an electric valve which supplied compressed air to a piston. In steadiness, ease of control and geneneral effectiveness the instrument is a great success, and the simplicity of its mounting commends it strongly to field astronomers.

About 110 pictures were secured in the clear intervals between the clouds, for the most part near the 1st and 4th contacts, though thirty were taken about midway between 1st and 2d contacts. Totality was a complete failure, by reason of heavy clouds which formed over the face of the sun as its light was gradually diminished after 1st contact, the sky being perfectly blue in several regions near the horizon, notably in the southeast. The Pensacola, by steaming out to sea about fifteen miles, saw the corona in a partial way and obtained a fair observation of the 2d and 3d contact instants. This mishap is the more aggravating as the Wednesday, Thursday and Friday preceding were magnificent days, Saturday only partially cloudy in the afternoon, and the following Monday and Tuesday fine once more. By common consent it is thought that the climate and meteorological conditions at this station are unusually favorable to such a purpose as our own in the month of December, and there are no regrets that we had not chosen some other position. An English party under Mr. Alber Taylor, of London, was located about an eighth of a mile to the east of us, but no other expeditions were sent to the African coast for observations.*

The other work of the Expedition includes the operations in Meteorology, Natural History, Anthropology, also Magnetic and Gravitation observations, the latter of which will be prosecuted at Cape Town, St. Helena, and Ascension Island.

It is only fair to say that the Expedition is enjoying its

* Mr. Taylor had mounted a 20-inch reflector of 22 inches focal length, and the 5-inch Dallmeyer that has served in earlier eclipse expeditions, and he likewise met with a total failure to make any observations. It is reported that the corona was seen on the river Quanza, some eighty miles from the ocean, but nothing more is known about it.

XUM

visit to Africa and profiting by the novel and important experiences through which it is passing.

CAPE LEDO, WEST AFRICA, Dec. 28, 1889.

THE OCCULTATION OF JUPITER, SEPT. 3, 1889.

WILLIAM H. PICKERING.*

FOR THE MESSENGER.

This occultation was observed at Wilson's Peak with the 13-inch telescope, and eight photographs were secured. They were taken with the enlarging apparatus, on a scale of $15'' = 1^{mm}$, and with an exposure of three seconds each. The first and second contacts occurred in the day time and so could not be observed. The third and fourth occurred about ten minutes after sunset. This caused the negatives to be somewhat fogged by the light of the sky, so that direct measures were impossible. They were accordingly enlarged to a scale of about $3'' = 1^{mm}$, and measurements made from the enlargements. All the negatives taken immediately after the occultation show the limb of Jupiter next the moon to be decidedly darkened. This is conspicuous and could not escape notice. The same limb is also darkened on other negatives taken on previous and succeeding days, and is undoubtedly due to the phase. In the photographs taken when about half of the disc was obscured there is no shade perceptible upon the face of the planet other than the belts.

Two photographs were obtained immediately after the fourth contact, when the following limb of Jupiter was respectively $1''.74$ and $8''.50$ from the limb of the moon. Four photographs were taken later when the distance was from $85''$ to $105''$. The line joining the centers of Jupiter and the moon was inclined very nearly 45° to the meridian, so that the two diameters of Jupiter measured radially and tangentially to the moon may be compared directly, without sensible correction for ellipticity of the disc.

Unfortunately the telescope was not pointed so as to bring Jupiter in the center of the plate. With the enlarging apparatus this introduces a considerable distortion; but as Jupiter always occupied the same position upon the plate, it is

* Harvard College Observatory.

presumed that the distortion was the same in all cases. Four measures of each of the two diameters were made upon each of the six photographs. The different measures of the same distance were made at different times, and in no case consecutively. The average deviation of a single measure in a series made upon the same plate is 0″.24. Comparing the four plates where Jupiter is remote from the moon, the average deviation of the mean difference of the two diameters on each plate from the mean difference of the four is 0″.35. The mean difference between the two diameters as measured on these four plates is 1″.85. Assuming the distortion the same, and that this correction applies to all six plates, we find the excess of the radial over the tangential diameter in the six plates amounts respectively to — 0″.75, — 0″.54, + 0″.32, + 0″.24, — 0″.69, + 0″.12. As the measures of the fifth plate gave a result which was unexpectedly small, it was re-measured. Using this second series of measures the correction for distortion becomes 2″.06, and gives for the six plates the following values, — 0″.96, — 0″.75, + 0″.11, + 0″.03, — 0″.03, — 0″.09. In other words, when near the moon's limb, the diameter of Jupiter measured in the direction of the moon's center was apparently reduced nearly a second of arc. Should this result be confirmed by future observations it would indicate a highly rarified lunar atmosphere, whose refractive power was about one three-thousandth part that of the earth's.

THE "RED LIGHT."

E. J. BROOKINGS.

For The Messenger.

The remarkable occurrences in the atmosphere which began in the autumn of 1883, and which continued with more or less intensity for a period covering nearly two years have passed into astronomic history under the name of the "Red Light," or "Red Sunsets," and the subject is now most too old to be discussed *per se*. But I noticed in a pamphlet just received from Professor Lewis Swift, entitled "History and Work of the Warner Observatory, 1883–1886," several essays on the subject (previously given to the public through

other sources I presume), all tending to the conclusion that the eruption of Krakatoa was the original cause, except that of Professor Henry C. Maine, of Rochester, N. Y., who maintains the theory that unusual disturbances in the sun and consequent action upon our earth's atmosphere, caused the unusual phenomena.

My object in referring to the subject is, not to enter into a discussion of it, but, as it seems to me, to correct an error of theory which Mr. Maine, in the ardor of maintaining his proposition, has fallen into, viz.: that the peculiar *halo* so long accompanying the sun in his daily revolutions (commonly speaking) during much of the time the phenomena occurred, was the solar corona.

I quote from his essay:

"The persistence of the peculiar halo about the sun for more than a year, while the red sunsets were very unequal, sometimes disappearing altogether, indicates that there must be several factors to produce the sunset phenomena. Some of these factors were less changeable than the others. The halo showed but little change for a long period, although it was noted that on most occasions the Red Light was brilliant at night when the halo was most conspicuous."

He then proceeds to assert an unusual solar energy during the period named, with the consequent effect upon the earth's atmosphere, and in specious argument and reasoning forms the theory that these conditions so intensified and extended the luminosity of the sun's corona that it could thus be seen during the period mentioned, as notice in his concluding remarks which I quote: "Bearing all these facts and theories in mind, is it not probable that the violent solar eruptions during the past five years have so loaded and extended the solar envelope that the nebulosity has become visible, and that the visibility began in the autumn of 1883? The effects of the solar eruptions upon our atmosphere might have been such as to aid in rendering the sun's envelope visible through vapor at an abnormal height. Such conditions explain the persistence of the solar halo, and its changes in form, while the sunset phenomena, which depended partly upon local atmospheric conditions, varied from day to day." * * *

His conclusion is as follows: From all these considerations it would seem that there is a reasonable presumption of a physical connection between the unusual solar activity and the Red Light, and that the one is the principal cause of the other."

The only point I wish to make in regard to the Professor's conclusions is, I fear, one which will upset the whole theory. It is this, that during the same periods, almost, when this solar halo persisted, a *lunar* halo was also distinct and persistent. Now why not ascribe the cause of these disturbances to lunar activity?

I myself was particularly, interested in this almost persistent solar halo, and to satisfy myself that it was at least mostly produced by atmospheric origin, I watched the moon quite as intently, and I noticed that the halos of each corresponded very nearly in periods and persistence. That I am not prejudiced, I would here remark that, at that time, my views of the subject quite closely corresponded with those of Mr. Maine; but were soon dispelled by cumulative evidence on all sides to the contrary.

It is possible that, during the remarkable atmospheric conditions of those two years, the corona of the sun itself might have been seen, in connection with earthly coronas, so often visible in vaporic or other elemental disturbances; but it does not follow that the quite continuous halo was produced by solar energy and solar coronal luminosity; in other words that it was produced by conditions exterior to earth itself. Besides it is well known there have been in other periods of years just as remarkable solar activities without corresponding results like those of 1883–1885.

Mr. Maine's doubts as to the ability of volcanic dust and vapor to persist in our atmosphere for so long a period is not, I think, based upon very good foundation, for I have seen evidences where the fine dust of cities (hardly comparable with the minuteness of volcanic matter) in midsummer, has remained for days in the air, and the smoke of burning forests for months.

The sediment of the Potomac water in spring-time (much to our disgust) will remain for weeks before settling. How much easier, then, would it be for the matter thrown from an immense eruption to an enormous height and in minut-

est condition, to maintain an apparent equilibrium amongst the currents of the upper air.

WASHINGTON, D. C., 1890.

PORTRAITS OF DISTINGUISHED ASTRONOMERS IN WOLFF-LEAVENWORTH COLLECTION OF SYRACUSE UNIVERSITY.

Certain legal technicalities having rendered void a section of the will of the late Gen. E. W. Leavenworth of Syracuse, N. Y. in which he had generously intended to make provision for Syracuse University, his widow, Mrs. Harriet T. Leavenworth, determined that his purpose should not be thwarted, purchased at her own expense the Wolff collection of engravings and presented it to the University. The collection represents the patient work of fifty years of Dr. Heinrich Wolff of the University of Bonn. Early in his student life he conceived the idea of gathering together the portraits of distinguished physicians of all times and countries, and steadily pursued that purpose until the day of his death. By watching the favorable opportunity, he was enabled, by purchase and exchange, to obtain many engravings that rarely come upon the market. On several occasions other collections were purchased and added to his own, so that at his death, when the whole was placed upon the market, it numbered about twelve thousand portraits.

Aside from its interest as illustrating the progress of the art of engraving, this remarkable collection will prove of value to all persons interested in scientific work of any kind. While Dr. Wolff intended it to be first of all a series of portraits of those who had contributed something to the science of medicine, he added portraits of distinguished men of all professions—alchemists, charlatans, astrologers, chemists, physicists, poets, philosophers, mathematicians each find their appropriate place. There are portraits of over three hundred astronomers and mathematicians in the collection, and it is with the thought that it may prove of value to some one interested in the history of Astronomy, that the following list of portraits of the more distinguished astronomers has been prepared. The numbers refer to the catalogue prepared while the collection was for sale at Frankfort on the Main.

XUM

134 Bacon, Roger; 12°.
143 Bailey, Francis; standing. Thomas Philipps, p. Th. Lupton sc. Gr. Fol.
220 Bradley, James; Hudson, p. J. Faber sc. Fol.
221 " " " " Tookey sc. 8°.
442 De Moivre, Abr.; J. Highmore, p. J. Faber sc. Fol.
461 Dollond, J.; Wilson, p. Mckensie sc. 12°.
462 " " Posselwaite sc. 8°.
509 Ferguson, James; J. Townsend p. R. Steward sc. Fol.
510 " " Northcote p. F. Haward sc. Fol.
511 " " T. Wright sc. 8°.
516 Flamsteed, Joh; Gibson p. G. Vertue sc. Fol.
517 " " 3 sheets by various engravers, small Fol, 8° and 12°.
608 Gregory, David. 4°.
633 Halley, Edmund; Murray p. 1712. J. Faber sc. Fol.
634 " " G. Kneller p. G. White sc. Fol.
635 " " 2 sheets. Phillips p. G. Vertue sc. 4° and 8°.
687 Herschel, J. F. W.; H. W. Pickersgill p. W. Ward sc. Gr. Fol.
688 " " after a Photo. Von Pound sc. Small Fol.
689 " William, Abbot p. Ryder sc. Fol.
690 " " after medallion of von Duhamel 8°.
691 " " F. Rehberg, p., 1814. J. Godby sc. Fol.
692 " " 2 sheets. C. Brandt lith. 4° and 8°.
910 Mc Laurin, Collin; 2 sheets. Trotter sc., 1798, and Freeman sc. 8°.
933 Maskelyne, Nevil; 12°.
934 " " 12°.
957 Molineux, William; Sherwin sc. Fol.
993 Newton, Isaac; G. Kneller p. J. Smith sc. 1712 Fol.
994 " " J. Houbracken sc.
995 " " Sitting with book, half fig. Aet. 85. Vanderbank p. J. T. Faber sc. 1726. Fol.
996 Newton, Isaac; G. Vertue sc. 4°.
997 " " half fig. J. Thornhill p. J. Simon sc. 1723 Fol.
998 " " P. Lely p. B. Reading sc. Fol.
999 " " E. Seeman p. J. M. Ardell sc. Fol.
1000 " " G. Kneller p. W. Sharp sc. 4°.
1001 " " 7 sheets by Von Lips, Dupin, Swaine, Kraus and others. Fol. and 8°.
1098 Ramsden, Jesse; R. Home p. P. Jones sc. Gr. Fol.
1253 Taylor, John; F. H. van Hove sc. 8°.
1465 Allemand, John; Nicholas Sebast. Fol.
1502 Arago, Dom Francois; Maurin lith. Fol.
1503 " " " Ambr. Tardien del. et. sc. 1824. 8°.
1504 " " " 2 sheets. Maurin lith. 8°.
1510 Argelander, F. W. A.; C. Mazen lith. 1837. Fol.
1511 " " A. Hohneck lith. 1852. Fol.
1567 Bailly, Jean Silvan; P. M. Alix sc. after David. Fol.
1568 " " " Delpech lith. Fol.
1569 " " " M. Bance sc. Medallion. 12°.
1570-1-2" " " 7 other portraits by various artists.
1736 Bernoulli, James; 2 sheets. 8°.
1737 " John; 6 portraits by various artists.
1765 Bessel, Friedrick Wilhelm; J. Wolf p. E. Mandel sc. Fol.
1766 " " " from another plate. Fol.
1806 Biot, J. B.; Maurin del and sc. Fol.
1807 " " 3 sheets by Bailly, Delpech and Tardien. 8° and Fol.
1823 Blanchino, Francois; Aet 67. 1729. 4°.
1854 Bode, John Elert; Half fig. Kraft del. Lith. Fol.
1855 " " " Kruger del. Olderman lith. Fol.
1856 " " " 2 sheets by D. Berger, 8°, and Malvieux, small Fol.
1957 " " " 4 " " Bolt, Lowe, Weitsch. 8°.
1915 Borelli, Gio Alfonso; Forino del. Fol.

1928 Boscovich, Roger Joseph. 8°.
1938 Bouguer, Pierre; Peronneau p. Miger sc. Fol.
1940 Bouilland, Ismael, Jag. V. Schuppen p. 1697. Fol.
1965 Brahe, Tycho; J. de Ghryn sc. 4°. *Rare.*
1966 " " 4°.
1967 " " J. Larmessin sc. 4°.
1968 " " 5 sheets. 8°.
2079 Burckhardt, Joh. Carl, 2 sheets, J. G. Schmidt sc., 1800, and Lith 8°.
2110 Cagnoli, Antonio; G. Vocchi del. G. A. Correggio sc., 1805. Small Fol.
2162 Carlini, Francesco; R. Hoffmann lith. 1859. Fol.
2174 Cassini, Jean Dominique; Half fig. L. Cossin sc. Fol.
2175 " " " 2 sheets. Beaubran p. N. Dupuis sc., and unknown. 8°.
2243 Clairault, Alex. Claude; entire fig. Carmontel del. Delafosse sc. 1768. Fol.
2244 Clairault, Alex. Claude; Half fig. C. N. Cochin del. Cathelin sc. Fol.
2288 Copernicus, Nicolas; N. Dandeau del. et. sc. Fol.
2289 " " Three sheets. Karcher, Daumont and another. 8° and 12°.
2380 D'Ambert, J.; Pujos del. 1774 Dupin sc. 4°.
2381 " "
2382 " " P. Maleuvre sc. Fol.
2383 " " Cochin del. Watelet sc. 1754. 4°.
2384 " " 3 sheets. Haid sc. Belliard lith. Fol.; and Delpech, lith, 8°.
2420 Delambre, Jean Baptiste Jos.; Quenedy del. Westermayr sc. 8°.
2422 De L'Isle, Jos. Nicolas; Westermayr sc. 8°.
2446 Descartes, Renatus; In cloak. F. Hals p. J. Snyderhoef sc. Fol.
2447 " " Anonymous. Fol.
2448 " " G. Edelinck sc.
2449 " " C. Van Dalen sc. Fol.
2450 " " E. Ficquet sc. 8°.
2451 " " 2 sheets by Benoist and Duhamel 8°.
2452 " " P. Schenck. Fol.
2453 " " Garnerey p. P. M. Alix sc. Fol. The same; J. V. Meurs sc. 4°.
2454 " " 6 sheets by various artists. Fol., 8° and 4°.
2645 Euler, Leonhard; Handman p., 1756. J. Stenglen sc., 1768. Fol. *Rare.*
2646 " " Half length. J. Darbes p. S. Kutner sc. 1780. Fol.
2647 " " 2 sheets. Dupin sc. and Mechel sc. 8°.
2648 " " 3 sheets by Darchon, Holland Pfenninger. 8°.
2676 Fabricius, James; J. M. Bernigeroth sc. Fol.
2750 Flamarion, Camille; Ettline sc. 8°.
2810 Frauenhofer, Joseph von; Waldherr del. Vogel sc. 8°.
2856 Galilei, Galileo; J. Suterman p. G. Cipriani sc. Fol.
2857 " " D. Tintoretto p. N. Schiavoni sc. Fol.
2858 " " Villamaena del. G. P. Benoist sc. 8°.
2859 " " 6 sheets by various artists.
2879 Gassendi, Peter; A. Mellan del. et. sc. small Fol.
2880 " " The same reduced to 8°.
2881 " " Nauteuil sc. 1658. Fol.
2882 " " J. Lubin sc. Fol.
2883 " " 3 sheets. Title pages to his works. Fol., 8°, 12°.
2889 Gauss, Carl Friedrich; Half fig. Jensen p. Rittmuller lith. Gr. Fol.
3305 Herschel, Friedrich W.; F. Rehberg p. F. Muller sc. Small Fol.
3306 " " " C. Muller sc.
3307 " " " 3 Woodcuts. Fol., 8°.
3326 Hevel, Joh.; Half fig. Jwenhausen p. J. Falck sc. Fol.
3327 " " A. Stech p. L. Visscher sc. Fol.
3328 " " 4°.
3455 Hughens, Christian; Half fig. Edelinck sc.

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3477 Hughens, Christian; Eques sc. Fol.
3478 " " from the other side. F. Otteus sc. Small Fol.
3479 " " A. Blootelingh sc. Fol.
3591 Kepler, John; Hondius sc. Fol.
3592 " " 4 sheets, 8°, and a wood cut. Fol.
3654 Kopernik, Nicolay; G. Colzi del. Sulucci lith. Fol.
3719 La Land, Jerome de; Ely del. A. de St. Aubin sc. Small Fol.
3720 " " 2 sheets. Pujos del. Ingouf sc., and Frischins sc. 8°.
3721 La Land, Jerome de; 3 sheets by Bonneville, Dupin and Westermayr. 8°.
3724 Lambert, Jean Henri; half fig. small Fol.
3764 La Place, Pierre Simonde;, 2 sheets. Schufft sc. 4°. Westermayr sc. 8°.
3818 Leibnitz, Gottfr. Wilh. von; Scheitz p. J. F. Bause sc. Fol.
3819 " " " " 3 sheets by Haid and others. 4° and 8°.
3820 " " " " 9 " " various artists. 8° and 12°.
3896 Lindenau, Bernhard von; 2 sheets. V. Grassi p. M. Steinla sc. Fol. Scherth lith. Fol.
3909 Lipperhay, Hans; Berckman p. J. V. Meurs sc. 2 sheets. 4°.
3913 Lithou, Jos. Joh.; 2 sheets. Kriehuber p. Pinhas sc. 8° and lith. 4°.
4053 Maupertius, P. L. Moreaude; Tourniere p. J. Daullee sc. 1741. Gr. Fol.
4055 Maupertius, P. L. Moreaude; 3 sheets. Daullee sc. and Derochers sc. 8°. J. J. Haid. Fol.
4068 Mayer, Tobias; 2 sheets by Riepenhausen and Westermayr. 12°.
4341 Olbers, Wilhelm; C. A. Schwartz p. J. G. Huck sc. 1808. Fol.
4342 " " J. G. Pflugfelder p. et sc. 1807. Fol.
4343 " " R. Suhrlandt del. et lith. Fol.
4344 " " 3 sheets by Mackenzie and others. 8°.
4492 Piazzi, Gius; Half fig. R. Focosi del L. Rados sc. Gr. Fol.
4493 " " Bust. Bossi sc. Fol.
4744 Rittenhause, David; Half fig. C. W. Peale p. J. B. Longacre sc. 8°.
5069 Schroeter, J. H.; 2 sheets. Strack del. Tischbein sc. Small Fol.; and anon. 8°.
5075 Schubert, J. T. von; Lithograph. Gr. Fol.
5098 Schwab, Joh. C.; Bollinger sc. 8°.
5312 Struve, W.; C. A. Jensen. lith. 1844. Gr. Fol.
5806 Zach, Franz Xavier von; Anon. 8°.

THE ENGLISH MILE.*

JACOB M. CLARK, C. E.

This itinerary, on account of its lack of geographical correlation and singular dimension, has evoked much interesting discussion, and been the means of bringing to the surface, under new aspects, a variety of important facts.

The reader is referred to a very instructive article in Vol. 25, p. 69, of this magazine,† giving a full abstract of the views of M. Faye, as read before the Paris Academy, "On the Origin of the English Mile."

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* Its Relation to the Size of the Earth, and to Ancient Metrics.
† *Van Nostrand's Engineering Magazine.*

In that paper, the writer favors the view that the dimension is traceable to the survey of Eratosthenes, compared with that of Ptolemy; and incidentally, that the surveys were conducted in terms of the Babylonian degree, and by implication, for the purpose of determining its length, or rather the subtense of one minute of arc; that the error in dimension arose partly from misapprehending the relative values of the stadia of different epochs, through disregarding the assumption that the computation of Eratosthenes was based on surveys made with the Egyptian foot* ($0.27^m = 10\frac{3}{8}$† inches), while the survey of Ptolemy was based on the Philetærian foot (nearly $0.36^m = 14\frac{1}{6}$ inches.)

Much additional light is thrown on the subject through a valuable contribution to these pages, from the pen of Professor Mansfield Merriman ("The Shape and Size of the Earth," *Van Nostrand's Magazine*, Vol. 22, pp. 53–92, 115–128, and 233–241). Reference is more particularly made to the different versions of the earth's circumference by ancient mathematicians on page 58. In the absence of direct evidence to the contrary, the results, the definition of amplitude observed by Eratosthenes, and the chronology,‡ as given by Professor Merriman, must be taken as clear and conclusive.

Hitherto, the moderns have regarded these statements as the results of successive experiments by the ancient geometers, to ascertain what has been supposed to be unknown to them—the length of the terrestrial degree, or, at any rate, the true circumference of the earth; and, on the face of it the discrepancy is certainly glaring enough to justify the impression, and, at the same time to suggest the theory both of serious errors in their work, and confusion among them as to the dimensions of the stadia used in the different surveys.

The true character and object of these operations can only

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*The Egyptian foot is uncertain. The dimension above given agrees very fairly with the ady of Malabar, the palmo of Malta, Messina, Naples, Sardinia, and Nice, the pied of Rouen, the stonecutter's schuh of Zug, and the miner's spanne of Prussia; dimensions varying from 10.265 to 10.570 inches

The Philetæric foot is quoted by Alexander as equivalent to 13.893 inches.

†Pliny gives the base of the Great Pyramid at 883 "feet"; this is correct, Pliny's "foot" being a "palmo" = 10.35 + English = 10.34 + geometric inches = ½ of a well-known form of the royal cubit. The Pyramid's base is = 9131.05 + geometric inches = 365.2422 + polar cubits, representing in polar cubits the exact number of days in the *tropical* year.

‡In a recent discussion (Trans. Am. Soc. C. E., vol. XI., p. 415), the writer, adopting this chronology, inadvertently placed Aristotle 200, instead of 100, years earlier than Archimedes.

be understood by reading them in the light of contemporaneous history and in view of the spirit of the times, aided by such knowledge of the actual dimensions made use of as can be obtained or fairly inferred.

It should be borne in mind that, as a rule, conquest has always involved more or less serious interference with the metrics of the people. And, from the nature of the case, this was a prominent feature of state policy among the ancients. So long as a subjugated, but powerful and intelligent people retained the use of their traditional measures, cherished by the philosophers, and indissolubly connected with the mysteries and service of the temple, their complete subjection would be a matter of doubt. But the perils involved in the sudden and arbitrary overthrow of entire systems, were generally, in fact, sought to be avoided by modifications—compromises, under more or less specious and flattering pretexts.

Now as to the measures—the stadia probably used—and the mode of reckoning:

The Greek stadium was ⅛ of their mile of 1,000 paces, or double parade-steps; value = 604⅜ feet. The Romans had practically the same mile. Elsewhere, the stadium was 100 fathoms, and the fathom, generally, 3 cubits. But the Hebrew fathom was 4 cubits.

The Egyptian, Phenician, and Persian cubit was 0.01 of the schœnus, which was equivalent to 145.92 English feet. The Hebrew cubit was $\frac{1}{80}$ of the schœnus.

The Babylonian cubit was apparently the subtense of 1° on a radius of 100 duodecimal feet, or 1,200 inches. Its value would depend on that of the inch. A form of it appears in Egypt, with some uncertainty as to the date of its introduction, under the name of the royal cubit.* The Turin and Nilometer cubits, so called, are versions of it. The dimension was not far from 1.75 feet. A slight modification, to be understood further on, would place it as = 1.75104 English feet.

There would result:

The Egyptian stadium = 437.76 English feet.

The Hebrew stadium = 729.6 English feet.

* The perfect royal cubit is the circumference of a circle upon 9 Egyptian digits as a diameter, the digit being one twenty-fourth of the Egyptian cubit.

The (supposed) stadium on fathom of 3 Hebrew cubits = 547.2 English feet.

The (supposed) stadium on fathom of 3 royal cubits = 525.312 English feet.

Among the peoples concerned, the reckoning, for all general purposes, was purely decimal, except that the Babylonians had the duodecimal mixed up in their system, with alternations of 6 and 10.

To facilitate the view, the different results are arranged in the table in chronological relation with prominent epochs, and in connection with the above lengths of stadia:

Epoch.	Event, etc.	Earth's circumference in stadia.	Length of stad. English feet.
B. C. 538	Babylon taken by Cyrus.		
B. C. 525	Independence of Egypt destroyed by Cambyses.		
B. C. 340	ARISTOTLE	300,000	437.76
B. C. 332	Macedonian Conquest; end of the Pharoahs.		
B. C. 250	ARCHIMEDES	*300,000	437.76
B. C. 230	ERATOSTHENES	250,000	525.312
B. C. 146	Greece made a Roman province.		
B. C. 90	POSIDONIAS	240,000	547.20
B. C. 30	Cleopatra's death; end of the Ptolemies; Egypt becomes a Roman Province.		
A. D. 170	PTOLEMY (in the reign of Marcus Aurelius)	180,000	729.60

With these values of the stadium the circumference in each case is 131,328,000 English feet.

By Clarke's elements of 1878, as quoted by Professor Merriman, the mean circumference is 131,331,455 English feet.

The skill and accuracy of ancient astronomers is strikingly illustrated by the survey of Almamoun, in Mesopotamia, in the ninth century, referred to for illustration by both Professor Merriman and M. Faye. Taking the Arabian mile (palpably a version of Ezekiel's 500 reeds) at Haswell's quotation, 2,146 yards, with the Professor's statement of the result, 56⅔ miles to the degree, the circumference is $2{,}146 \times 3 \times 56\frac{2}{3} \times 360 = 131{,}335{,}200$ feet, a trifle above the ancient and modern, in a total disagreement as to the whole circumference of less than a mile and a half.

Both Egypt and Mesopotamia are fairly situated for apprehending the mean circumference by meridian observations.

Leaving aside, for the moment, the above suggested adjustment of the royal cubit, the question arises pretty distinctly whether the most promising theory to square with all the facts may not, after all, be something like this:

(1.) At the very earliest assignable epoch, the mean circumference of the earth, and consequently its radius, were known with astonishing precision. Under a very perfect system of geometry, the metrics of the ancient leading nations were founded on this knowledge, The opinions of Aristotle and Archimedes were derived from this source, through Egypt.

(2.) After the Macedonian conquest, it became apparent that, by the breaking up and commingling of nationalities, the multiplicity of units was inconvenient and perplexing. The Mosaic and Babylonian cubits were in collision. The "cubit and a hand-breadth" of Ezekiel, by this time widely diffused and popularized, differed from the two-foot rule by about an inch. The Egyptian and Persian cubit was becoming confounded with the Indian* cubit of 18 inches. And the Greek measures were a new element of discord. Eratosthenes was charged by Ptolemy Philadelphus with the work of reform. To satisfy the prevailing preferences for the decimal method, and at the same time strike a reducible mean among the cubits, an itinerary was invented which should be an even decimal of four terrestrial great circles. It is more than probable that the survey of Eratosthenes was simply to test the correctness of the ancient standards and fix the adjustment of the royal cubit. The circumference was already known, according to the Egyptians, and if their account proved correct, the *relation* was apparent beforehand. The royal cubit would have to be six-fifths of the Egyptian = twenty-four twenty-fifths of the Mosaic = 1.75104 English feet.

(3.) This unwieldy division of the circle, unfit for geography or astronomy, along with the strong preferences of the Egyptians, Persians, Hebrews, and kindred races for the

* It is a peculiarity of the purely duodecimal method that, reckoning from the inch, it has no longer dimension than the 12-feet pole or "joktan." And, wherever it has taken root, this dimension, as well as its derivatives by bisection, the valgar fathom, the yard and the Indian cubit, as also the foot when used as units, are, as a rule, but with occasional intermediaries of 3 and 6, reckoned upwards decimally. Its singular distribution—about the Mediterranean, among the islands as Great Britain and Japan, and upon the salients of Africa and Asia—is strikingly suggestive of the maritime enterprise of busy Tyre.

ancient measures, and their wide-spread traditional sympathy as against Babylonian methods, finally broke this system down. Accordingly, after the Roman supremacy was established, and in the reign of one of the later Ptolemies, Posidonias restored the Mosaic cubit, but in a 3-cubit fathom, so that his itinerary was decimally related to the hour-angle. And so far from his survey being the worst measurement of a degree ever made, it serves to verify in a very lucid way the work of his predecessors. The aptness of his system, as an itinerary, is attested by the survival of the Turkish mile, through all vicissitudes, and of its correlative fathom, by dozens of analogues, in the islands and along the Mediterranean and in central Europe. And it may seem significant to many that in the Apocalypse, written 186 years later, the division of the circle by 24 is paramount.*

(4.) Finally, in the reign of Marcus Aurelius, a further attempt at unification seems to have been made by re-instituting the Mosaic itinerary—the leuga of the ancient Gauls and the mile of Sardinia. This was the survey of Ptolemy. Possibly it involved some concession to the Egyptians, in that the schœnus became simply 20 fathoms, instead of 33⅓ as by their ancient method, or 26⅔ as by that of Posidonias. It lacked, however, the key note of Ezekiel's reform —*radius* to be the base of direct and square measure, itinerary to be ruled by the division of the circle.

There seems to be little either in the accounts we have, the necessities of the case, or the character of the rulers under whom these operations were conducted, to indicate that they were instituted for any other purpose than that above suggested—verification of the ancient work, and adjustment of the standard for the particular purpose in view at the time. Neither is it apparent that in any of them, the Babylonian degree was either used or its dimension sought (except possibly as to Ptolemy), or that the Egyptian foot, whatever it may have been, or the Philetærian foot or the Greek stadium, were used or referred to at all, or that the geodetic work had any other fundamental base than the ancient public surveys of Egypt, familiar to the learned throughout the whole period of operations, and unquestion-

* See I. Chronicles, chaps. xxiii., xxiv., xxv., and xxvii. Also Josephus Antiq., Book vii., chap. 13, for King David's strict ideas of circular geometry. A similar system is indicated in the dedication of the tabernacle, Numbers vii.

ably made with the schœnus. And this view is confirmed by Eratosthenes' definition of amplitude, as quoted by Professor Merriman—$\frac{1}{50}$ of 4 right angles—a decidedly decimal expression, as well as by the general ancient preference for the decimal method.

The English mile, by its dimension, suggests with strong probability that it was at first either equal to 1751 yards,* representing the survey of Eratosthenes, or else 1824, like the Turkish mile, the itinerary of Posidonias; and that it took its present form at the time the English forced the 36-inch yard into their land measure by means of the invention of Gunter's chain. The former is the more probable of the two.

ILLUMINATION FOR A POSITION MICROMETER.

G. W. HOUGH.†

FOR THE MESSENGER.

Incandescent lamps, for illuminating the circles and micrometer wires of an equatorial telescope, have been in use for some years. When, however, a primary battery is employed for generating the electricity, I am informed that the trouble of keeping the battery in order is a serious obstacle to its success. The employment of storage cells obviates all difficulties.

During the past five years I have used three simple storage elements, each consisting of two sheets of lead 4 × 6 inches covered with red-lead, and hung in a glass or stone jar, containing dilute sulphuric acid. These cells are charged by seven gravity elements; the whole kept constantly connected in series.

A storage cell of this kind will yield a current of about three ampères, and the lead plates will last two years without removal. My cells have been in constant use for operating the printing chronograph, door bells and for other pur-

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* = 12 Egyptian stadia = 3600 Egyptian cubits = 1½ Russian versts.
The Russian correlation is: Earth's *mean circumference* = 3750 Swede miles = 37,500 versts = 18,750,000 sagine = 56,250,000 archine = 900,000,000 verschok. The verschok is one-tenth of the Egyptian cubit.
The Asiatic pic (= 26.24 geometric inches) is one ten-thousandth of the ancient *parasang*.
The co-relations of ancient typical systems come out clear through ancient zodiacs and cyclar methods of time-reckoning.

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poses. They also give satisfactory results with a one or two candle incandescent lamp. Commercial storage cells may now, however, be purchased of a capacity of 25 ampère hours and upwards, which, of course, would be preferable. Three cells connected in series with seven gravity elements will be charged at the rate of one to two ampère hours in one day. If more electricity is required the number of the charging gravity elements may be increased.

At the old site of the Dearborn Observatory in Chicago, I used a small gas burner for illuminating the wires of the position micrometer. The light was fairly under control and generally satisfactory.

After re-mounting the 18½-inch refractor on the new site at Evanston, not having gas in the building, I started with an old oil lamp, which sometimes smoked, was frequently blown out, and was generally in the way when not measuring. I accordingly decided to try electricity. A telegraph line carrying a No. 8 copper wire having been erected between the Observatory and the Physical Laboratory, the distance being half a mile, I was able to make use of the storage battery located at the latter place. An incandescent lamp of one candle power was inserted in one of the arms of the position micrometer, first placing a disk of deep red glass in front of the lamp. A resistance coil of five ohms was then prepared and subdivided in five equal parts, so that any position of this resistance could be introduced in the circuit, at the will of the observer. One wire was connected with the mounting of the telescope and carried down the tube to the lamp. The other wire was brought up at the base of the pier and loosely coiled when not in use. The free wire was left of sufficient length to reach the eye-end of the telescope in any position. When measures are to be made the loose wire is connected with the lamp; it being necessary to detach it only when the telescope is reversed. Both lines might be permanently attached to the telescope, as has already been done by Grubb and others, but the loose wire answers every purpose.

By passing *all* the light through deep red glass, one gets a clean field with scarcely any stray light used by means of the resistance coil, which is fastened to one of the counterpoise arms, within reach of the observer, one can instantly

get any degree of illumination, a very great desideratum in dealing with difficult double-stars or faint satellites. I have now used this method of illumination for some months, and it is found to be so much superior to either gas or oil that I should be very unwilling to go back to the old plan.

We expect, in a short time, to connect the Observatory with the public electric light wires and use incandescent lighting both for the equatorial and the meridian circle.

Observatories which cannot have access to commercial lighting, may easily charge a few storage cells, for micrometer illumination. An incandescent lamp, such as I use, requires a current of about five volts and one ampère.

Eight gravity elements joined in series against three commercial storage cells, and kept constantly connected, would easily furnish all the light required for an equatorial micrometer.

A COMPOUND WEDGE PHOTOMETER.*

E. J. SPITTA, L. R. C.†

The idea of employing a wedge of neutral-tinted glass as a photometer has occurred to many observers—Dawes, Capt. Abney, and others—and notably of late years to Professor Pritchard, of Oxford, who has produced with such an instrument his well known *Uranometria Nova Oxoniensis*, a catalogue of the relative brightness of the brighter stars north of the equator. But the use of such an instrument has always been limited hitherto to the comparison of the relative intensities of such points of light as the stars present, its employment upon objects of sensible area being foreign to the ideas and requirements proposed in its construction. Having, however, attempted to use a photometer of this description upon disks of small but of various areas illuminated by a known amount of light, the discordances of the results forced upon me the necessity of modifying the construction of the photometer in a way which I believe will extend its sphere of usefulness. It is not within the scope of this paper to give any detailed account of the many

* From the proceedings of the Royal Society.
† Communicated by Capt. W. de W. Abney, C. B., F. R. S. Received November 8, 1889.

experiments I have made with several wedges, but it is sufficient to say that the wedge-form itself has been fully proved to be an important factor in the production of the discordances to which reference has been made, for the following reasons:—.

A point of light from its very definition implies that no sensible portion of the wedge is occupied in its passage, but it requires very little thought to perceive that when an area of sensible dimensions is being dealt with this is by no means the case. Morever, an elementary inquiry suffices to point out that if the area possess a considerable diameter the light emanating from its lateral portions will impinge on different thicknesses of the wedge, as shown to an exaggerated degree in fig. 1, where AB is the transverse diameter

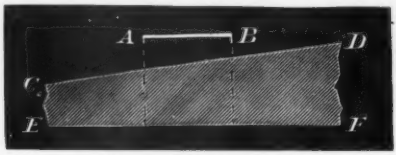

FIG. 1.

of the area, and CDEF the portion of the wedge employed. It is evident if the differences in intensity be required between two disks of the same diameter this condition of things would not affect the validity of the final results, but it is equally apparent that were the disks of differing diameter the values obtained could not but be seriously affected. Let it be presumed that two such different-sized disks were under consecutive examination, as shown in fig. 2, AB representing the diameter of one and CD that of the other. In the case of AB it is manifest that the extreme limb B would be fainter to all appearance than the oposite edge A, because the light issuing from it has to traverse a portion of the wedge EF, thicker and so more dense than E′F′. On consideration, it is equally obvious that the limiting margin A will be the last to appear as the wedge is made to move from right to left till disappearance takes place, the position technically spoken of as "the point of wedge extinction." But if CD, the larger disk, be illuminated with light of the same initial intensity as fell on AB, it is evident that the

point of wedge extinction (technically so-called) for CD at the limb C will not be at the same wedge-reading as in the previous case; in fact, disappearance would not occur until the portion of the wedge corresponding to the line E′F′ had been moved to occupy the position shown by the line E″F″. Hence, when ascertaining what is termed the wedge-interval in the direct comparison, say, of the relative intensities of a large and small disk, it is very obvious an error entirely due to the physical nature of a wedge must inevitably result, such error being in direct proportion to the amount of shift

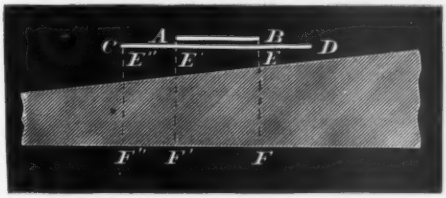

FIG. 2.

required, which depends upon the relative differences in diameter of the disks under observation. Nothing is here said of the difficulties of observation, which are enormously increased by the different apparent intensities of the light at the extremities of the diameter parallel to the length of the wedge, because I merely wish to call attention to the error resulting from the employment of the wedge-form itself.

To apply a correction under these circumstances was not deemed expedient, even if found to be practically possible; hence the removal of the source of error has been arrived at by devising an instrument of different construction, to which the term Compound Wedge Photometer has been applied, and of which the following is a brief description:

Two very thin wedges of neutral-tinted glass are made to slide past one another with a uniform rate of motion by the turning of a single milled-headed screw, the idea of the arrangement being diagrammatically set forth, so far as the wedges themselves are concerned, in fig. 3, where it will be seen that any amount of density, within certain limits, can be obtained by equal movement of the two wedges, although a uniformly absorptive area in all parts of the field is rigidly maintained. In the figure, ABC is shown as one

XUM

wedge, DEF the other, and VIEW the field of view. A cursory inspection of the arrangement at once reveals its most salient advantages, and the fact that any sized disk within the limits of the field of vision will be observed by the same density of neutral-tinted glass at any and all parts of its image, and hence that the cause of error spoken of as arising from the use of a single wedge is at once removed.

An instrument so constructed has been subjected to several months' crucial testing, and I have no grounds for thinking it does not fulfil the requirement for which it was devised.

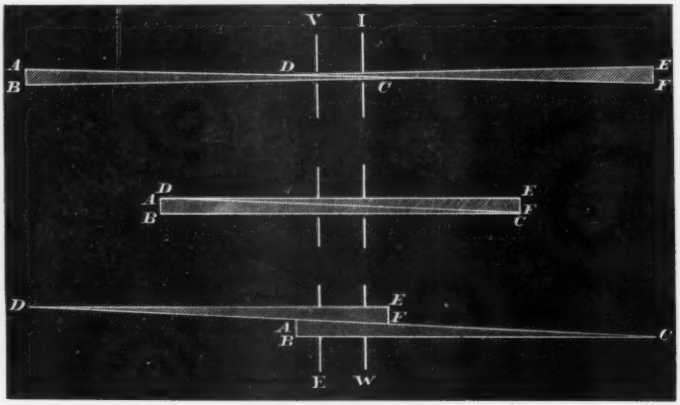

FIG. 3.

In its final form the arrangement differs from that usually met with as suggested by Professor Pritchard, for it is supplied with a rotating disk of metal, perforated at intervals to allow the permanent insertion of pieces of nutral-tinted glass of different thickness, each of which can be evaluated for magnitude and used as a constant. Besides, it is fixed upon the occulting eye-piece, a device for limiting the aperture at the eye-end of a telescope, or for occulting any portion or portions of the field of view, and which I have fully described in vol. 45 of *Monthly Notices of the Royal Astronomical Society*.

The vacancy on the Council of the Royal Society caused by the death of Father Perry, has been filled by the election of the Astronomer Royal.

NOTICES FROM LICK OBSERVATORY.

Announcement of the discovery of the rotation period of Mercury, by M. Schiaparelli.

On the 8th of December, 1889, the *Accademia dei Lincei** of Rome held a special sitting, which the King and Queen of Italy attended in order to hear a discourse by M. Schiaparelli on his discovery of the rotation period of the planet Mercury.

From a report of this meeting and from a short paper in the *Astronomische Nachrichten* the following brief account is condensed:

The rotation periods of the planets Mercury and Venus must be fixed, if at all, by the observation of the spot on their surfaces. Neither of these planets is ever to be found at any considerable angular distance from the sun, so that they must be observed in the twilight or in the day-time. At all Observatories the images of planets in the day-time are wavering and unsteady and at some stations (as at the Lick Observatory, for example)† daylight observations can almost never be made to advantage. At Milan, M. Schiaparelli has been able to observe Mercury some 150 to 200 times in the years 1881-6, with the eight-inch telescope; and since that time he has used the eighteen-inch telescope, which has confirmed his earlier conclusions.

The fundamental facts relating to the rotation of the planets are:

I. If Mercury is observed on two consecutive days the aspect of its spots is identical or nearly so; and the same is true when the interval between observations is two, three or four days, etc. This fact of observation can be explained by either one of three hypotheses: (*a*) the rotation period of Mercury is about twenty-four hours; (*b*) or the planet makes two or more rotations in this period; (*c*) or the rotation is so slow that an interval of two or three days makes no appreciable alteration in the position of the markings.

II. The observations at Milan showed Professor Schiapar-

* Galileo was one of the original members of this Academy (*dei Lincei*—of the Lynxes—of the sharp-eyed ones) which was named after the fantastic manner of the day.

† See *Publications of the Astronomical Society of the Pacific*, Vol. II, p. 27

elli, to his satisfaction, that the motion of the spots on the apparent disc was too slow to permit of the possibility of the hypotheses *a* or *b*. It followed therefore that the rotation period was of *many* days.

III. Observations in 1882-3 confirmed in 1886-7 showed that the planet revolved about the sun at least somewhat as the moon revolves about the earth, namely: in turning always the same face, or nearly the same face, to the primary body. The observations themselves were so difficult that it was impossible to prove that Mercury revolved on its axis *exactly* in the period of one revolution in its orbit (as in the case of the moon). Professor Schiaparelli takes the sidereal period of Mercury (87.9693 days) at once as its rotation time, although his observations might be satisfied by a period some four hours or so different from this longer or shorter.

IV. The observations were too difficult to permit the determination of the position of the rotation axis, but all his drawings agree with the assumption that the axis of rotation is approximately perpendicular to the plane of the orbit. It is certain that the axis is not inclined as much as 23° or 25° (like the earth's or Mars') and it is not likely that the inclination varies from 90° by as much as 8°.

V. All the observations tend to demonstrate that the rotation of the planet on its axis is uniform; from which datum, combined with the notable eccentricity of Mercury's orbit, it follows that there must be a large libration in longitude with respect to the radius-vector. The period of this libration is eighty-eight days and its amplitude is twice the maximum equation of the center or, 47° 21′.

The author dwells on the extreme difficulty of seeing the faint markings at all, and of depicting them when seen, but gives a planisphere of the hemisphere turned toward us. On the equator three points are marked, O (center of the disc) and two points A and B, 23°41′ from O, and on either side of it. O is the point turned towards the sun (the point which has the sun in the zenith) at the times of perihelion and aphelion; A and B are the two points which have the sun in the zenith at the times of greatest positive or negative libration.

Considering the difficulty of seeing the spots on Mercury

at all it is not easy to give any well-founded opinion as to their nature. They may simply depend upon the diverse materials and the structure of the solid strata of the surface as in the case of our own moon. But, as Mercury is known to have a dense atmosphere, Professor Schiaparelli thinks that it would not be unreasonable to conclude that they might be analogous to our own seas. With regard to this point, he says: "We have in the case of Mercury (as in Mars) a world which is sufficiently diverse from our own, which receives light and heat from the sun, not only in a greater amount but in a different manner from the earth; and where life, if so be life exists there, finds conditions so different from those to which we are accustomed that we can scarcely imagine them. The perpetual presence of the sun almost vertically above certain regions, and its perpetual absence from other regions, appears to us to be something intolerable. But we must recollect that such a contrast should produce an atmospheric circulation which is at the same time stronger, more rapid and more regular than that which sows the elements of life on the earth, and that on this account it may come about that an equilibrium of temperature is produced over all the planet which is far more complete than with us."

The foregoing is a very brief summary derived from the important and elegant papers which have already been published in advance of the more elaborate memoir, in which Professor Schiaparelli will discuss all his observations for the nine years 1881–1889. As early as 1882 M. Schiaparelli announced to one of his correspondents (M. Terby) his discovery in the verses which follow:

Cynthiæ ad exemplum versus Cyllenius axe
Æternum noctem sustinet, atque diem:
Altera perpetuo facies comburitur æstra,
Abdita pars tenebris altera sole caret.

In 1888 Professor Schiaparelli asked the attention of the astronomers of the Lick Observatory to the inferior planets, and Mr. Schæberle, Mr. Barnard, and myself have observed Venus and Mercury in the day-time on a very great number of occasions with the Meridian-Circle and with the twelve-inch equatorial, but with little success. For reasons which I have given in full in the Hand-Book of the Lick Observa-

tory (page 26) we shall never be able to make delicate observations in the day-time at Mt. Hamilton. A station on one of the very small coral islands of the South Pacific Ocean has the very best conditions for this class of observations, and a mountain Observatory has the very worst. On only one occasion during the past two years was it worth while to turn the great telescope upon Venus in the day-time, and for a very few moments the view was somewhat better than it had been in the twelve-inch. If the observations of M. Schiaparelli require confirmation an expedition to one of the smaller *atolls* of the Pacific would yield the surest and the quickest results. E. S. H.

BAILEY'S BEADS.

LEWIS SWIFT.*

For The Messenger.

This curious phenomenon, always accompanying total and annular eclipses of the sun, is, if carefully observed, one of the most striking of the many phenomena visible on such occasions, and as, to my mind, no satisfactory explanation has been advanced for its production, and, inasmuch as I have studied carefully at three different eclipse occurrences its formation, I have thought that a short paper on the subject might not be wholly uninteresting to the readers of The Sidereal Messenger.

When the moon, advancing eastwardly over the sun, has reduced the sun's eastern limb to a very narrow crescent, it suddenly breaks up into many luminous objects extending from end to end of the crescent, and bearing, sometimes, so strong a likeness to a string of beads, that they have received the name of "Bailey's Beads," because first accurately described by Mr. Francis Bailey in 1836, though seen long before by Halley and others. Some four or five seconds before the advancing moon uncovers the western limb of the sun, they are in like manner produced at that edge of the disk, and present nearly the same appearance as at the eastern limb.

For a long time, perhaps quite naturally, the cause assigned was the visibility of the sun through the interstices of

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the lunar mountains. This theory was, until recently, from its very simplicity, received with almost universal credence, though after three or even two careful observations of this phenomenon, I think no astronomer would endorse it, as the idea that twenty or thirty lunar mountains are so evenly spaced and so precisely alike as to so admit the passage of sunlight that they shall produce contours so alike and so symmetrical is not tenable.

Perhaps I cannot do better than to reproduce my descriptions of them as observed at Denver, Colorado, in 1878 (as reported to Professor Colbert and published by the Chicago Astronomical Society in that year,) and, also, as seen at Nelson, California, on January 1, 1889.

"Several seconds previous to the formation of the beads, I observed near each end of the solar crescent a phenomenon which I have never seen described in any of the books, and, though reminding me of the "Black Drop" which I saw at the last transit of Mercury, yet it was very different from the latter. Please allow me to describe it. Imagine a long and very narrow crescent cut in a door between two rooms, one dark, the other brilliantly lighted, the observer being in the dark one. The appearance was as if two concealed persons in the lighted room, one on each side of the crescent, were busy in protruding and then withdrawing a series of long, slim, opaque objects like writing pencils. Only twice did I see the images appear opposite each other, as is always the case with the black drop. These appearances continued for about two seconds and then, after ceasing for a second, recommenced farther from the end of the sun's limb, now reduced to a much narrower crescent, but the images were shorter and larger and more irregular in size. This lasted only about a second and again ceased as if waiting for a grand *denouement*, and then came the formation of Bailey's Beads, beginning simultaneously at each end of the crescent, now only a curved line of silver light, and regularly and quickly meeting at the center they seemed to give a succession of quivers and instantly vanished.

These luminous beads appeared to be square (trapezoidal) and from the center each way decreased in a regular geometrical ratio, and, could one-half of them have been superimposed upon the other, they would have agreed in curvature,

size, distance, shape and brilliancy. When I take into consideration the exact uniformity of their formation as to time and the other similarities above noted, I cannot subscribe to the generally received opinion that they are the sun's light seen through the interstices of the lunar mountains. The intelligent reader will not be slow to conceive how serious and numerous are the objections against receiving as true so improbable a theory, especially as those formed at the beginning are precisely like those at the end of totality."

The following report to Professor E. S. Holden, now incorporated in Lick Observatory Eclipse volume, gives their appearance as seen from my station at Nelson, California, which was as unlike that of my former observation as two things can well be, I quote from a manuscript which, in its final revision, was slightly changed:

"BAILEY'S BEADS."

"There has been much speculative writing concerning this singular and, at times, beautiful phenomenon observed at every total and annular eclipse for, at least, a century. The usually assigned cause is the shining of the sun through depressions between lunar mountains, a theory which, when compared with observed facts, has no support. As I saw them in 1878, every one was trapezoidal in shape and differed in size only, being mere points at each end of the cresent, but increasing gradually and regularly towards its center. At the California eclipse they bore no resemblance to those seen at Denver, for, instead of being trapezium shaped they, at both second and third contacts, resembled a curved series of dotted i's or, more exactly the letter *a* (dot and dash) of the Morse telegraphic alphabet, thus: . — . — . — . — . —. Professor Charles A. Schott says of those seen in 1869, "I would particularly notice their great regularity in width, outline and distribution." Professor D. G. Eaton says, "Bailey's beads were very conspicuous. Just before totality the thin cresent was broken by *dark lines shooting out from and perpendicular to the edge of the moon.*"

From the above quotations added to observations of my own, I am irresistibly led to the conclusion that they, like the color of the protuberances, are not seen alike by all, and

that the true cause has never been arrived at. Were I, however, to hazard an opinion, it would be that they result from a phenomenon closely allied to, if not identical with, that causing the "Black Drop." It is also quite likely that diffraction may have much to do with it and possibly may be its sole cause. Were the usually assigned reason the true one, as there are mountains all round the moon, then, on the occasion of an annular eclipse, when the moon so nearly equals the sun in size as to render the annulus exceedingly narrow, the "Beads" should be seen all round the moon. Again, long before a total phase is reached, the ends of the crescent, all the time reduced to a hair-like fineness, ought to reveal them, which is not the case."

On both of the above occasions, the same telescope and eye-piece were used, viz: A power of 35 on a 4½ inch achromatic contracted to three inches. At the Denver eclipse, when the two supposed intra-mercurial planets were discovered I believed and published that the magnifying power used was 25. Several months afterward a measurement showed it to be 35. I had misunderstood Mr. Gundlach, its maker, who says he informed me correctly of the power.

Warner Observatory, Rochester, N. Y., March 18, 1890.

TIME SERVICE.

G. W. HOUGH.*

For THE MESSENGER.

In the Jewelers' Journal and Horological Review appears an article entitled, "U. S. Government System of Observatory Time," by Lieutenant Hiero Taylor, U. S. Navy. The following statement is made: "The Naval Observatory was the *pioneer* in the distribution of time. Other observatories have *since* made it a part of their work, and have given, so far as is known, satisfaction to the localities of which they are the time centers. In a number of cases they make use of the system which has been adopted at the Naval Observatory. This system and the methods by which its objects are accomplished are known as the Gardner System of Observa-

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tory Time. It has been adopted by the Government for its time balls and time signaling service, as it is the simplest and most certain known for the automatic distribution of time."

I think if the writer of the above paragraph had made a little inquiry as to what had been done by other Observatories in the United States in the matter of furnishing time to the public, he would probably have been more careful in his statement.

The time service of to-day, like everything else, has been a gradual development, beginning with the invention of the telegraph.

The first step was the transmission of signals for longitude; the second, the automatic transmission of signals by means of a clock and the invention of the chronograph.

It is not my purpose to give a detailed history of the progress of time distribution in the United States but simply state what was done at one Observatory.

In the years 1856-58 Dr. B. A. Gould, Director of the Dudley Observatory, at Albany, N. Y., arranged with the New York Central Railroad for a time service, and procured the necessary clocks and other apparatus. Owing to Dr. Gould's retirement from the Observatory, the system was never put in practical operation. When I went to the Dudley Observatory in the year 1860, I found two clocks provided with cams and electrical attachments for setting the hands, daily or hourly. I believe this method was the invention of Moses G. Farmer. The same plan is now in general use with some slight modification in mechanical construction. I also found a signal clock with a disk in the second's hand shaft having a single notch, so that automatic signals could be transmitted once each minute.

In the year 1859-60 time balls located in New York City and on the Capitol in Albany were dropped at noon of each day by means of signals sent from the Dudley Observatory. The signals were sent by hand. The New York time ball was soon after discontinued.

In the year 1861 I put the necessary connections in a mean time clock so that a signal would pass only once in twenty-four hours, and so arranged with switches that it could be sent in any hour or minute. This clock was used

for dropping time balls, located in the Capitol and at the foot of State street in the city of Albany. This method, which was entirely automatic, was in use for a couple of years, when the ball in the Capitol was discontinued. It was found from experience that the time balls were of comparatively little use to the public.

In the year 1864 I arranged a mean time clock to send automatic signals hourly, or more frequently if necessary. As I believe this system of signals was among the first ever devised, it may be desirable to state definitely what they were. The necessary mechanism was placed in the mean time clock so that, on the fifty-ninth and sixtieth minutes of each hour, the circuit was opened and closed every two seconds from the fiftieth to the sixtieth second. The breaks in clock beats were about one half second in length. The system was especially arranged in this manner so that time could be sent over a line of telegraph without interfering with the ordinary commercial business, except during the twenty seconds in each hour when the signals were passing.

The signal in the fifty-ninth minute called the attention of the operator so that time could be taken in the following minute. In case a message was being transmitted when the clock signals were passing over the line, it was only necessary to stop sending during the ten seconds, after which the message could be resumed.

This system was first put in operation on a line of telegraph connecting the Observatory with a jeweler in the city of Albany.

In the year 1866 the Western Union Telegraph Company put the Dudley Observatory on a commercial wire connecting the cities of Albany, Troy, etc., and communicating with the general Western Union office and the railroad offices in the city of Albany. And from 1866 to 1874 this system of time distribution was in successful operation at the Dudley Observatory. At noon of each day the time was sent by the central office over the main telegraph lines in every direction. From 1859 to 1866 the Dudley Observatory time was used on the New York Central and Hudson River railroads, and subsequent to 1866 on all the railroad lines centering in Albany. In 1868 the Observatory was connected with the fire-alarm office in the city of Albany, to whom the

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clock signals were also transmitted. The fire-alarm office provided mechanism for striking the church bells at 9 A. M. and 9 P. M. daily on Observatory time.

The foregoing facts and dates may be found in the Annals of the Dudley Observatory, Vols. I and II.

AN APPROXIMATE SOLUTION OF EULER'S EQUATION FOR PARABOLIC MOTION.

O. C. WENDELL.*

FOR THE MESSENGER.

The form in which Euler's equation to be solved by trial, is given in Watson's Theoretical Astronomy, is expressed in the following six equations:

$$\tau = k(t'' - t) \qquad \eta = \frac{2\tau'}{(r + r'')^{\frac{3}{2}}}$$

$$k = \frac{2\tau'}{r + r''}\mu \qquad d = (k^2 - A^2)^{\frac{1}{2}}$$

$$r = \left\{\left[\frac{d+c}{b}\right]^2 + B^2\right\}^{\frac{1}{2}} \qquad r'' = \left\{\left[\frac{d+c''}{b''}\right]^2 + B''^2\right\}^{\frac{1}{2}}$$

The method usually adopted in the case of a first orbit, as is known, is to assume $(r + r'')$ equal to 2 and then to solve the above equations several times in succession until the desired result is reached, but when a number of trials are neccessary, as is generally the case, and especially when the problem converges slowly, the process becomes laborious and consumes considerable time. A very short abridgement leading to a close result as a first assumption I have found in the following way:

If in equation 4 we substitute the value of k as given in equation 3, we have

$$d = \left[\frac{(2\tau'\mu)^2}{(r + r'')^2} - A^2\right]^{\frac{1}{2}}$$

Then, assuming that $\mu = 1$ and that r and r'' are equal we have:

$$d = \left[\frac{2(\tau')^2}{r} - A^2\right]^{\frac{1}{2}} \qquad (1)$$

an equation in which r is the only variable.

* Harvard College Observatory.

Again Equation 5 of the original equations can be better transformed as follows:

$\frac{d+c}{b}$ is the sine of an angle, φ suppose, of which B is the cosine, the angle being formed by the comet's radius-vector and a perpendicular let fall from the sun upon a line joining the comet's with the corresponding earth's place.

Then we have $\frac{d+c}{bB} = \tan \varphi$ (2)

and $r = B \sec \varphi$ (3)

By solving the last three very simple equations twice with an assumed value of r at the beginning and then making use of ordinary correcting formula $q = q_0'' - \frac{a''^2}{a' - a}$ where a represents the difference between the first and second and a' between the second and third values of r, a close approximation to r is reached by a very few minutes labor for use in the more complete formulæ. In these trials only three or four place logarithms need be used. I have employed this abridgment with advantage in several orbits, the most extreme case being that of the orbit of Barnard's comet discovered July 7, 1885.

My assumption for r was 1, or 0.000 for log r. Two solutions, however, of the above equations, with the additional use of the correcting formula, above mentioned, gave me 0.40 for log r or 2.5 for r itself, the exact value of the mean of the two radii-vectores being, as subsequently determined, 2.5230.

Harvard College Observatory, March 8, 1890.

Temperature of the Moon, from studies at the Alleghany Observatory by Professor S. P. Langley, with the assistance of F. W. Very. We have been favored by a copy of Part 2, Vol. IV., National Academy of Sciences, third memoir, entitled "The Temperature of the Moon," and also a copy of a paper published in the American Journal of Science in December, 1889, which is supplementary to, and completes, the investigation of 1883, and continued for the next four years. The principal conclusion drawn from this most intricate and long continued research, is that the mean temperature of the sunlit lunar soil is much lower than has been supposed, and is most probably not greatly above zero Centigrade. The attention that these excellent papers have attracted in foreign scientific journals is very flattering to the author and is justly the pride of American scholarship.

CURRENT CELESTIAL PHENOMENA.

THE PLANETS.

Mercury, passing through superior conjunction April 9, will not be visible to the eye during the early part of the month of April. On May 5 it will be at greatest elongation east, 21°18′ from the sun. The declination of the planet at this elongation will be about 24° north, so that it will be in a most favorable position for observation. It will be seen in the west for several evenings from 8^h to 9^h, a little north of the west point of the horizon, not far from the Pleiades and the red star Aldebaran. The latter part of this month will be a most favorable time for the study of the surface of Mercury in full sunlight, with the aid of a telescope. Probably the best views can be had between 5 and 7 P. M. The diameter of Mercury's disk will vary from 5.2″, April 15, to 10″, May 5.

Venus may also be seen in the west in the evening from 8 to 9, and is in excellent position for daylight observations of the gibbous phase. The diameter of her disk will increase from 10″ to 11″, while the illuminated portion of the disk decreases from 0.970 to 0.927. Venus and Mercury will be in conjunction April 25 at 10 P. M., Mercury being 2°04′ north of Venus. They will be in conjunction again May 10 at 1 A. M., Mercury being 1°45′ north of Venus. On May 5 at 3 A. M. Venus and Neptune will be in conjunction, Venus north 2°02′. We shall have thus three planets in the same portion of the sky, two of which, though small, are so near as to be visible to the unaided eye, the other, though much larger, so distant as to be invisible to the eye and very faint in the telescope.

Mars will be best seen toward the south about midnight. He is among the bright stars in the constellation of Scorpio, a little northeast of the red star Antares. He will be in conjunction with the moon April 9, 6 A. M., 0°45′ south of the latter, and again May 6, 2. P. M., 1°44′ south. On May 1 Mars will be about 54,000,000 miles distant from the earth; his apparent diameter will be 17.2″ and his phase 0.969.

Jupiter is still among the faint stars of Capricorn, visible in the southeast in the morning. His apparent polar diameter on May 1 will be 37.6″. Jupiter will be at quadrature, 90° west from the sun, at midnight April 30. We give this month tables of the phenomena of the Satellites, but have at hand no ephemeris for the transits of the great spot.

Saturn will be at quadrature, 90° east from the sun, May 18. He is in excellent position for observations in the early evening, situated in the constellation of Leo near the bright star Regulus. The angle between the plane of Saturn's rings and the line joining the centers of earth and Saturn will be at its greatest for this opposition, 11°20′, in May. The apparent major axis of the outer ring will then be 41″ and the minor axis 8″.

Uranus will be at opposition to the sun April 14, and therefore in position to be observed during the whole night. He is in the constellation of Virgo about one third of the way from Spica to Kappa Virginis.

Neptune will be too low in the west to be well seen. It will be in conjunction with Mercury, about 4°14′ south of the latter, on May 3 at 4 P. M.,

and in conjunction with Venus 2°02′ south, on May 5 at 3 A. M. Neptune is in Taurus about half way between the Pleiades and the Hyades.

We give this month the places of the four planetoids Ceres, Pallas, Juno, and Vesta, taken from the "Companion to the Observatory" for 1890. These are given at intervals of twenty-four days near the time of opposition. The "Berlin Jahrbuch" for 1892, which gives the daily places of the planetoids in 1890, has not yet come to hand. The opposition of Vesta occurred January 18; Pallas will be at opposition April 29, Ceres May 17, and Juno May 26.

MERCURY.

1890.	R. A. h m	Decl. ° ′	Rises. h m	Transits. h m	Sets. h m
April 25.....	3 18.1	+20 18	5 34 A.M.	1 03.2 P.M.	8 32 P.M.
May 5.....	4 16.0	+23 56	5 34 "	1 21.5 "	9 09 "
15.....	4 43.8	+23 54	5 23 "	1 09.8 "	8 57 "

VENUS.

April 25.....	3 18.9	+18 19	5 44 A.M.	1 03.8 P.M.	8 23 P.M.
May. 5.....	4 09.4	+21 27	5 40 "	1 14.8 "	8 49 "
15.....	5 01.5	+23 37	5 42 "	1 27.6 "	9 13 "

MARS.

April 25.....16	47.0	−22 30	10 02 P.M.	2 29.7 A.M.	6 58 A.M.
May 5.....16	42.5	−22 50	9 20 "	1 46.0 "	6 12 "
15.....16	32.8	−23 02	8 32 "	12 57.0 "	5 22 "

JUPITER.

April 25.....20	50.9	−18 08	1 49 A.M.	6 37.3 A.M.	11 26 A.M.
May 5.....20	55.0	−17 53	1 12 "	6 01.8 "	10 52 "
15.....20	57.6	−17 45	12 35 "	5 25.0 "	10 16 A.M.

SATURN.

April 25.....	9 59.3	+14 05	12 42 P.M.	7 43.2 P.M.	2 44 A.M.
May 5.....	9 59.4	+14 04	12 03 "	7 04.0 "	2 05 "
15.....10	00.3	+13 57	11 25 A.M.	6 25.5 "	1 26 "

URANUS.

April 25.....13	30.5	− 8 49	5 45 P.M.	11 13.8 A.M.	4 42 A.M.
May 5.....13	29.0	− 8 40	5 04 "	10 33.0 "	4 02 "
15.....13	27.6	− 8 32	4 23 "	9 52.3 "	3 22 "

NEPTUNE.

April 25.....	4 05.8	+19 14	6 27 A.M.	1 50.8 P.M.	9 15 P.M.
May 5.....	4 07.2	+19 19	5 49 "	1 12.9 "	8 37 "
15.....	4 08.7	+19 23	5 10 "	12 35.1 "	8 00 "

THE SUN.

April 25.....	2 12.6	+13 21	4 59 A.M.	11 57.8 A.M.	6 56 P.M.
May 5.....	2 50.8	+16 24	4 45 "	11 56.5 "	7 08 "
15.....	3 29.8	+18 59	4 32 "	11 56.2 A.M.	7 20 "

CERES (1)

April 17.....16	08	−12 47	9 11 P.M.	2 28 A.M.	7 35 A.M.
May 11.....15	50	−12 43	7 18 "	12 30 "	5 42 "

PALLAS (2)

April 5.....15	35	+18 07	7 22 P.M.	2 41 A.M.	10 00 A.M.
29.....15	24	+23 43	5 05 "	12 51 "	8 37 "
May 23.....15	04	+26 11	2 57 "	10 57 P.M.	6 57 "

JUNO (3)

1890.	R. A. h m	Decl. ° ′	Rises. h m	Transits. h m	Sets. h m
April 5	16 53	− 7 31	10 20 P.M.	3 54 A.M.	9 28 A.M.
29	16 46	− 5 25	8 30 "	2 12 "	7 54 "
May 23	16 28	− 3 40	6 32 "	12 21 "	6 10 "

VESTA (4)

April 17	8 59	+25 31	10 19 A.M.	6 15 P.M.	2 11 A.M.
May 11	8 29	+23 59	9 22 "	5 10 "	12 58 "

THE MOON.

April 20	3 08.5	+14 30	6 07 A.M.	1 13.3 P.M.	8 27 P.M.
25	7 38.6	+23 55	9 21 "	5 22.9 "	1 23 A.M.
30	11 48.9	+ 6 49	2 25 P.M.	9 12.8 "	3 49 "
May 5	16 00.6	−19 16	8 16 "	1 14.2 A.M.	6 03 "
10	20 27.6	−22 32	12 38 A.M.	5 15.9 "	9 50 "
15	1 06.1	+ 1 48	3 19 "	9 32.8 "	3 55 P.M.

[The above tables give local times for the Central Meridian and latitude +44° 28′.]

Minima of Variable Stars of the Algol Type.

	R. A. h m s	Decl. ° ′	Approx. Central Times of Minima.
U Cephei	0 52 32	+81 17	Apr. 19, 8 P. M.; 24, 8 P. M.; 29, 7 P. M.; May 4, 7 P. M.; 9, 7 P. M.
S Cancri	8 37 39	+19 26	May 2, 8 P. M.
δ Libræ	14 55 06	− 8 05	April 20, 8 P. M.; 27, 8 P. M.; 30, 4 A. M.; May 7, 3 A. M.; 14, 3 A. M.
U Coronæ	15 13 43	+32 03	April 22 3 A. M.; 29, 1 A. M.; May 5, 11 P. M.; 12, 8 P. M.
U Ophiuchi	17 10 56	+ 1 20	April 18, 2 A. M.; 18, 10 P. M.; 23, 2 A. M.; 23, 10 P. M.; 28, 3 A. M.; 28, 11 P. M.; May 3, 3 A. M.; 3, 11 P. M.; 9, 1 A. M.; 14, 1 A. M.

Phenomena of Jupiter's Satellites.

	d.	Central Time. h. m.					d.	Central Time. h. m.			
April	16...	4 23	A.M.,	III.	Ec.	Dis.	May 4...	1 16	A.M.,	III.	Sh. In.
	21...	4 26	"	I.	"	"		4 50	"	III.	Sh. Eg.
	22...	2 32	"	II.	Tr.	Eg.	6...	2 15	"	II.	" "
		3 02	"	I.	Tr.	In.	7...	2 42	"	I.	Ec. Dis.
		4 02	"	I.	Sh.	Eg.	8...	1 17	"	I.	Tr. In.
		5 22	"	I.	Tr.	Eg.		2 18	"	I.	Sh. Eg.
	23...	2 32	"	I.	Oc.	Re.		2 37	"	II.	Oc. Re.
	27...	2 38	"	III.	Tr.	In.		3 37	"	I.	Tr. Eg.
		2 47	"	IV.	Ec.	Dis.	9...12	49	"	I.	Oc. Re.
	29...	2 17	"	II.	Tr.	In.	13...	1 09	"	IV.	Ec. Re.
		2 30	"	II.	Sh.	Eg.	15...12	31	"	III.	Oc. Dis.
		3 35	"	I.	"	"		1 50	"	I.	Sh. In.
	30...	4 27	"	I.	Oc.	Re.		3 09	"	I.	Tr. In.

Occultations Visible at Washington.

Date.	Star's Name.	Magnitude.	IMMERSION. Wash. Mean T. h m	IMMERSION. Angle f'm N. P't. °	EMERSION. Wash. Mean T. h m	EMERSION. Angle f'm N. P't. °	Duration. h m
April 22...	105 Tauri.....	6	7 30	109	8 32	189	1 01
23...	1 Geminorum.	5	9 11	128	9 59	239	0 48
25...	82 "	6½	8 36	110	9 47	281	1 11
May 13...	B.A.C. 17.....	6	15 16	11	15 51	300	0 35

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Phases of the Moon.

			Central Time. d	h	m	
New Moon	1890	April	19	2	06	A. M.
First Quarter	"	"	26	10	52	P. M.
Full Moon	"	May	4	3	09	P. M.
Last Quarter	"	"	11	10	22	A. M.
Apogee	"	April	26		Noon.	
Perigee	"	May	8	4	24	P. M.

Ephemerides of Saturn's Satellites.

[Computed by A. Marth, Monthly Notices R. A. S., vol. L, No. 1, p. 57. Reduced to Central Time.]

Apr. 15	1.2 p. m.	Rh. w.	Apr. 24	10.6 p. m.	En. n.	May 5	11.2 a. m.	Di. n.
	6.0 p. m.	Mi. n.	25	8.6 a. m.	Te. s.		1.1 p. m.	Mi. n.
	10.1 p. m.	Te. s.		3.0 p. m.	En. s.		5.8 p. m.	Te. n.
16	7.4 a. m.	Di. n.		3.5 p. m.	Mi. s.		8.9 p. m.	Rh. e.
	4.1 p. m.	Rh. s.		5.0 p. m.	Rh. s.	6	2.1 p. m.	En. s.
	4.7 p. m.	Mi. n.		9.3 p. m.	Di. s.		4.5 p. m.	Te. s.
	5.3 p. m.	En. n.		10.2 p. m.	Di. ed.?		8.1 p. m.	Di. s.
	8.7 p. m.	Te. n.	26	7.2 a. m.	Te. n.		9.1 p. m.	Di. ed.?
17	4.1 a. m.	Tit. s. 38″		2.2 p. m.	Mi. s.	7	12.0 a. m.	Rh. n.
	3.3 p. m.	Mi. n.		8.1 p. m.	Rh. e.		3.1 p. m.	Te. n.
	4.2 p. m.	Di. s.	27	5.9 a. m.	Te. s.		9.6 p. m.	Mi. s.
	7.2 p. m.	Rh. e.		6.2 a. m.	Di. n.		11.0 p. m.	En. s.
	7.4 p. m.	Te. s.		11.2 p. m.	Rh. n.	8	3.2 a. m.	Rh. w.
18	1.9 p. m.	Mi. n.	28	4.6 a. m.	Te. n.		4.9 a. m.	Di. n.
	6.0 p. m.	Te. n.		3.0 p. m.	Di. s.		1.8 p. m.	Te. s.
	6.6 p. m.	En. s.		4.0 p. m.	Di. ed.?		3.5 p. m.	En. n.
	10.3 p. m.	Rh. n.	29	2.3 a. m.	Rh. w.		8.2 p. m.	Mi. s.
19	1.1 a. m.	Di. n.		3.2 a. m.	Te. s.	9	6.3 a. m.	Rh. s.
	4.7 p. m.	Te. s.		11.8 p. m.	Di. n.		12.4 p. m.	Te. n.
20	1.4 a. m.	Rh. w.	30	1.9 a. m.	Te. n.		1.8 p. m.	Di. s.
	9.9 a. m.	Di. s.		5.4 a. m.	Rh. s.		2.8 p. m.	Di. ed.?
	3.3 p. m.	Te. n.	May 1	12.5 a. m.	Te. s.		6.9 p. m.	Mi. s.
	7.9 p. m.	En. n.		8.5 a. m.	Rh. e.	10	9.4 a. m.	Rh. e.
	10.4 p. m.	Mi. s.		8.7 a. m.	Di. s.		11.1 a. m.	Te. s.
21	4.5 a. m.	Rh. s.		9.7 a. m.	Di. ed.?		4.8 p. m.	En. s.
	12.4 p. m.	En. s.		6.6 p. m.	Mi. n.		5.5 p. m.	Mi. s.
	2.0 p. m.	Te. s.		7.0 p. m.	En. n.		8.1 p. m.	Tit. n. 35″
	6.8 p. m.	Di. n.		11.2 p. m.	Te. n.		10.6 p. m.	Di. n.
	9.1 p. m.	Mi. s.	2	11.6 a. m.	Rh. n.	11	9.8 a. m.	Te. n.
22	7.6 a. m.	Rh. e.		5.2 p. m.	Mi. n.		12.5 p. m.	Rh. n.
	12.6 p. m.	Te. n.		5.5 p. m.	Di. n.		4.1 p. m.	Mi. s.
	7.7 p. m.	Mi. s.		9.8 p. m.	Te. s.	12	7.5 a. m.	Di. s.
	9.3 p. m.	En. s.	3	2.5 a. m.	Tit. s. 37″		8.4 a. m.	Te. s.
23	3.6 a. m.	Di. s.		2.7 p. m.	Rh. w.		8.5 a. m.	Di. ed.?
	10.7 a. m.	Rh. n.		3.8 p. m.	Mi. n.		2.7 p. m.	Mi. s.
	11.3 a. m.	Te. s.		8.4 p. m.	En. s.		3.6 p. m.	Rh. w.
	1.7 p. m.	En. n.		8.5 p. m.	Te. n.		6.2 p. m.	En. n.
	6.3 p. m.	Mi. n.	4	2.4 a. m.	Di. s.	13	7.1 a. m.	Te. n.
24	9.9 a. m.	Te. n.		3.4 a. m.	Di. ed.?		4.3 p. m.	Di. n.
	12.5 p. m.	Di. n.		12.8 p. m.	En. n.		6.7 p. m.	Rh. s.
	1.9 p. m.	Rh. w.		2.4 p. m.	Mi. n.	14	5.7 a. m.	Te. s
	4.9 p. m.	Mi. s.		5.8 p. m.	Rh. s.		7.5 p. m.	En. s.
	9.3 p. m.	Tit. n. 36″		7.2 p. m.	Te. s.		9.8 p. m.	Rh. e.

En. = Enceladus; Di. = Dione; Jap. = Japetus; Mi. = Mimas; Rh. = Rhea; Te = Tethys; Tit. = Titan; e. = conjunction; e. = eastern elongation; w. = western elongation; n. = north of center of planet; s. = south of center of planet. The conjunctions of the three innermost planets with the ends of the ring take place in the case of Mimas about 3.6h, Enceladus, 3.2h, Tethys, 3.5h before and after the predicted conjunctions with the center, which are not observable.

A New Planetoid No. 288 was discovered by Luther at Hamburg, February 24.4650 in right ascension $10^h\ 17^m\ 37.1^s$ and declination $+ 14°\ 53'\ 20''$. It is of the eleventh magnitude having daily motion in right ascension $- 48'$ and in declination $+ 6'$.

New Minor Planet (289?). A new minor planet of 13th magnitude was discovered by Charlois March 10.346, right ascension $9^h\ 41^m\ 23^s.6$, declination $8°\ 53'\ 33''$.

New Minor Planet (290?). A new Minor planet of 13th magnitude or fainter was discovered by Palisa, of Vienna, March 20.4787, in right ascension $12^h\ 24^m\ 5^s.4$, in declination $+2°\ 7'\ 28''$. Daily motion in right ascension—25′, in declination—10′.

Sunspots. A good sized group of spots was noticed near the northeast limb of the sun March 4 containing one large spot with two umbræ, and surrounded by brilliant faculæ. This spot was conspicuous for several days but on the 13th had so diminished as to be seen with difficulty.

Solar Prominences, February, 1890. Number of observations, 9; greatest number of prominences seen in one day (single observation), 11 on the 13th; least number of prominences seen in one day, 1 on the 26th; height of highest prominence observed, 80″, on 26th; mean number of prominences daily, 4.5; prominences distributed as follows:

	North.	South.
Between 0° and 10°	4	2
" 10 and 20	3	6
" 20 and 30	2	3
" 30 and 40	7	1
" 40 and 50	0	6
" 50 and 60	2	7
" 60 and 70	0	0
" 70 and 80	0	0
" 80 and 90	0	0
Total	16	25

Chromosphere during month low and billowy.

E. E. READ, JR.

Camden Observatory, March 1, 1890.

Smith Observatory Observations. The following solar observations were made with helioscope in February, 1890; power, 98.

1890.	90 m. M. T.	Groups.	Spots.	Faculæ.	Seeing.	Remarks.
1 Feb.	2 P. M.	1	1	0	Fair.	Gran. good.
6 "	2 15 "	0	0	1 gr.	"	Fac. near N. E. limb.
8 "	2 20 "	0	0	0	"	
9 "	2 15 "	0	0	0	Very poor.	Thin clouds.
10 "	10 A. M.	0	0	0	"	
11 "	10 45 "	0	0	1	Good.	Fac. faint; gran. good to limb.
12 "	2 55 P. M.	0	0	1	Fair.	Fac. bright on E. limb; gran. good.
13 "	2 25 "	0	0	0	"	No distinct fac.; gran. fair.
14 "	11 20 A. M.	0	0	0	Very poor.	Glimpses through clouds.
15 "	12	0	0	1	Good.	Fac. brilliant on S. W. limb; whole surface very sharp and clear.
16 "	3 P. M.	0	0	0	"	No distinct fac.; "faculissimæ" in many places.
17 "	11 15 A. M.	0	0	0	Clouds.	Impossible to make out anything definite.
18 "	11 30 "	0	0	0	"	Impossible to make out anything definite.
20 "	11 15 "	0	0	0	Poor.	Gran. poor and dif.
21 "	2 00 P. M.	0	0	0	"	Haze and clouds.
23 "	2 45 "	0	0	0	Fair.	Gran. sharp at intervals; coarse in center of disk.
24 "	3 45 "	0	0	1	Poor.	Fac. near N. E. limb.
28 "	2 00 "	0	0	0	Lt. clouds.	Could not make out gran. structure.

Smith Observatory, Beloit College.
Beloit, Wis., March 10, 1890.

CHAS. A. BACON.

Dartmouth Notes. The group of sun-spots which appeared by rotation on March 4th is interesting on account of its high latitude. It was preceded on the third by an eruptive prominence the height of which I estimated as 60″, and by other fainter diffuse prominences at nearly the same position-angle. These, I suppose, are to be considered the "elevation" view of the bright faculæ which surrounded the spot for the first few days. When the group was first seen at 1:30 (Eastern standard time) on March 4 the penumbra was invisible on the western side (*i. e.* the side furthest from the limb), thus showing distinctly the effect of depression. As groups which give data for finding the solar drift in this latitude are rare, (Carrington based his conclusions on observations of three groups), I append the values found for the heliographic latitude and longitude from day to day:

			λ		l	
March 4	3:35 P. M.		= 32°	33′ north.	= 194°	51′
5	2:15		32	33	193	38
7	2:00		32	39	194	9
8	2:10	Nucleus A.	33	1	194	17
		Nucleus B.	32	13	195	15
		Mean	32	42	194	46
9	12:30	Nuclues A.	33	18	192	1
		Nucleus C.	31	46	192	47
		Mean	32	32	192	24
10	12:15	Nucleus A.	33	43	191	41
		Nucleus C.	31	42	192	43
		Mean	32	43	192	12

From this it appears that the drift is about the same in λ and l, as found by Carrington, but before final conclusions are drawn it will be well to wait for observations separated by a longer interval, if the life of the spot is sufficient to permit this.

Judging from the diagram of the observations at Greenwich published in the *Monthly Notices* for November, 1889, I conclude that so large an area has not been disturbed in so high north latitude since 1874, excepting, perhaps, 1880.

I would like to make note of a fine meteor reported to me by several persons as observed at 8:55 P. M. (E. S. T.) on Jan. 20th. It appeared as large as the moon, of a white color, and fell through some 40° S. E. in Orion lighting up the sky, and finally broke into several pieces.

Hanover, N. H., March 11, 1890. EDWIN BRANT FROST.

Proper Motion of the Double-Star South 503.—J. E. Gore has shown in *Monthly Notices*, Vol. 50, No. 1, that the proper motion of the double-star South 503, is 0″.65 per annum in the direction of position-angle 138°.04.

Orbit of Struve 228. J. E. Gore says: Recent measures show that the binary star, Struve 228, has described about 120° of its apparent orbit since its discovery in 1829. The orbit as computed by Mr. Gore is as follows:

P =	88.73 years	Ω =	84° 49′
T =	1906.03 .	λ =	31 36
e =	0.5311	a =	0″.98
i =	70° 59′	μ =	+ 4°.057

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COMET NOTES.

Comet 1885 II. In *Astronomische Nachrichten*, No. 2952, Dr. Berberich gives two sets of definitive elements of this comet, the first without making any assumption as to the eccentricity, resulting in a hyperbolic orbit, the second assuming the orbit to be parabolic. The first satisfies best the normal places, with the exception of the last one, which depends upon a single observation. The parobolic elements, however, satisfy all the observations nearly as well and the last one better than the hyperbolic elements.

	(*A*) Hyperbola.	(*B*) Parabola.	
T	1885 Aug. 5.574653	Aug. 5.718966	Berlin mean time.
ω	178° 27′ 01.61″	178° 30′ 04.47	Mean Equinox 1885.0
Ω	92 17 09.67	92 17 45.72	
i	80 39 26.33	80 37 34.31	
$\log q$	0.3992904	0.3991079	$q = 2.50673$
e	1.0028519	1.0	

Comet 1884 III (Wolf.)— In *Astronomische Nachrichten*, No. 2953, there is an interesting paper on the "Former Orbit of Comet 1884 III," by R. Lehmann-Filhes. This comet is now moving in an ellipse with a period of about 6½ years, but has not been seen at a previous apparition. Professor Krueger showed that it must have passed very near Jupiter in 1875 and that its orbit must have been greatly changed then. Herr Lehmann-Filhes has computed the perturbations by Jupiter and has endeavored to calculate the orbit which the comet had before its encounter with the planet in 1875. We give below the elements of the present orbit by Thraen and those derived by Lehmann-Filhes for the former orbit.

Epoch	1884 Sept. 27.5		1875 April 5.0	
M	352° 31′ 59″.16		226° 32.6′	
Ω	206 18 29 .17		208 26.8	
ω	172 42 30 .62	1880.0	157 12.4	1880.0
π	19 00 59 .79		5 39.2	
i	25 15 42 .82		29 26.6	
ϕ	34 07 14 .69		23 01.2	
$\log e$	9.7489155		9.592245	
$\log a$	0.5539247		0.620840	
μ	523.74469″		415.668	
Period	2474.48807 ^{d} = 6.78 yrs.		3117.8 ^{d} = 8.54 yrs.	

It will be seen that the eccentricity and major axis of the orbit have been greatly changed. The comet was before 1875 moving in a much larger ellipse of which the least distance from the sun was over 2.5 times that of the earth. This would account for the invisibility of the comet in former years.

The Comets of 1889.

Designation		Synonym.	Discoverer.	Date.	Perihelion.	Ω
Comet 1889	I	*e* 1888	Barnard,	Sept. 2	Jan. 31.2091	357°25′15″
	II	*b* 1889	Barnard,	Mar. 31	June 10.8067	310 42 10
	III	*c* 1889	Barnard,	June 23	June 20.7816	270 58 04
	IV	*e* 1889	Davidson,	July 19	July 19.3072	286 10 30
	V	*d* 1889	Brooks,	July 6	Sept. 29.7436	17 58 30
	VI	*f* 1889	Swift,	Nov. 17	Nov. 29.6641	331 26 40
1890	I	*g* 1889	Borrelly,	Dec. 12	Jan. 26.869	12 16

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	ω	i	q	e	Computer	Reference
I	340°27′40″	166°22′13″	1.81489	1.001086	Berberich	A.N. 123, 280
II	236 04 49	163 50 26	2.25559	1.0	Millesovich	A.N. 123, 207
III	60 08 05	31 12 50	1.10240	0.956665	Berberich	A.N. 123, 77
IV	345 51 44	65 57 30	1.03949	0.994742	Campbell	A. J. IX, 119
V	343 18 56	6 04 00	1.95023	0.472726	Knopf	A.N. 123, 123
VI	69 29 13	10 03 21	1.33831	0.631214	Zelbr.	A. N. 123, 255
I	197 22	57 35	0.2740	1.0	Hill	S. M. IX, 88

Comet a 1889 was discovered by Brooks January 14 in right ascension $18^h\ 04^m$ declination south 21° 20′, but was not afterward seen by anyone.

Ephemeris of Comet 1889 I (*continued from page 135*).

	α app.	δ app	log r	log Δ
	h m s	° ′		
April 17	18 42 06	−8 20.8	0.7135	0.6806
21	39 30	8 11.0		
25	36 39	8 01.6	0.7192	0.6747
29	33 34	7 52.6		
May 3	30 15	7 44.0	0.7248	0.6697
7	26 43	7 35.9		
11	18 22 57	−7 28.2	0.7304	0.6660

A new comet was discovered by William R. Brooks March 19.875, in right ascension $21^h\ 9^m$, in declination + 5° 35′.

NEWS AND NOTES.

We are sorry to set over matter again because of the failure of our engravers to furnish the quality of work demanded.

We have not space for much in hand about the United States Naval Observatory position in regard to the Western Union time service of this country. But we will say as sure as the public press does its duty, and the astronomers of the United States have courage enough to stand by their convictions and the right, something will be done pretty soon.

U. S. Scientific Expedition to West Africa. We have received bulletins Nos. 2, 6, and 8. The first refers to the meteorological work of the expedition and was prepared by Professor Cleveland Abbe under date of 18th of October, 1889. No. 6 was by the same author concerning Water-spouts and bears date 7th November, 1889. Bulletin No. 8 was prepared by Professor Frank H. Bigelow, subject, Eclipse Photography, and bears date 20th November, 1889. It gives a brief summary of the units, the formulæ, and the process of interpreting the intensities of the light of the corona, for the guidance of the observers of the eclipse for which they were preparing.

Death of Professor Jacob Ennis. By a copy of the Houston Daily *Post*, recently received, bearing date of Jan. 19, we have the sad news of the death of Professor Jacob Ennis, at his home in Houston, Texas. Professor Ennis garduated at Rutger's College, joined the Dutch Reformed

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church, by which he was sent to the islands of Java and Sumatra as a missionary, where he labored four years. Returning to his native country, he was elected Professor of Natural Science in the National Military College at Bristol, Pa., and later he became principal and proprietor of the Scientific and Classical Institute of Philadelphia in which position he spent the best part of his life. He also occupied, for some years, the chair of Physical Science in the State Normal School of Shippenburg, Pa. His life was quiet, simple, dignified but laborious. He found considerable time outside of routine duty for study and original investigation in physical and speculative astronomy, as the titles of the following papers show: "The Meteors and Their Long Enduring Trails," "Elements of Sidereal Astronomy," "Electrical Constitution of our Solar System," "Physical and Mathematical Principles of the Nebular Theory," "Origin of the Power which causes Stellar Radiation," "Four Great Eras of Modern Astronomy," and many others on kindred topics. Professor Ennis wrote several articles for this journal which have appeared from time to time, and only last year he was preparing an elaborate article on the later phases of astronomical research which we had the pleaure of perusing, in part, before it was completed. Professor Ennis will be missed from a large circle of friends both east and west.

A Simple Approximate Formula for the Refraction. I have for several years given to my class in practical astronomy a formula for the refraction in zenith distance which is so convenient for many purposes that it deserves to be more widely known. The formula is:

$$\text{Refraction} = \frac{b}{470 + t} \tan z$$

where b is the barometric pressure expressed in thousandths of an English inch, t the temperature of the air in degrees Fahrenheit, and z the apparent zenith distance. For all ordinary values of the temperature and pressure this expression represents Bessel's refractions between the zenith and 75° zenith distance, within a second of arc (1″) and is therefore abundantly accurate for all sextant work and for most observations with other portable instruments.

An equivalent expression in different units is:

$$\text{Refraction} = \frac{21.5\, b}{273 + t} \tan z$$

where b is to be expressed in millimeters and t in degrees Centigrade.

In each case the formula gives the value of the refraction in seconds of arc. Somewhat greater accuracy can of course be obtained by writing $\tan (z - f r)$ in place of $\tan z$, Bradley's refraction formula, but it does not seem necessary to introduce this refinement. GEO. C. COMSTOCK.

Washburn Observatory, Feb. 26, 1890.

The Mechanics of the Solar System is the title of a neatly printed and illustrated pamphlet of seventy pages, having the title of "The Principles of Mechanics as Applied to the Solar System." The author's name is not given, but the name of his agent is P. Ervine, of San Francisco, California.

This pamphlet aims to account for the motions of the planets and other celestial bodies on the principles of attraction *and* repulsion, chiefly active in the plane of the equator of the sun for the planets, and in the equatorial plane of the planets respectively for their systems of satellites. The first question that the practical astronomer would ask is: What has the author observed in the mechanics of the solar system that calls for the principle of repulsion in the very general way in which he uses it? If the principle of gravitation, as now known, will explain nearly all the phenomena to which this pamphlet refers satisfactorily, is it not unnecessary to make the assumption of *two* forces acting in a particular plane to do the same thing? We admit that only those who have some independence in the higher mathematics can satisfactorily handle the abstruse problems of the motions of two or three celestial bodies, but such scholars are well agreed as to the general principles that govern the motions of all the bodies of the solar system and many more. Again, we think, the author has probably not read that excellent book entitled "Astronomy without Mathematics," by Sir Edmund Beckett, or he would not have written as he did about the "Tides." There is another grand book, now in the course of publication, which takes up this matter of the tides more fully and thoroughly than the one just named, and that is the "Old and New Astronomy," begun by the late Professor Proctor about two years ago. Over half of the book is in print, in pamphlet form, and was temporarily suspended at his death.

The author's attempt to explain some hard questions in astronomy is certainly a creditable one, and what he has said is perfectly clear, and his illustrations are especially well drawn to represent his ideas. The MESSENGER encourages all such honest effort, though it be necessary to begin again almost anew.

Fresnel's Mirror Experiment. In the March number of the *American Journal of Science* Albert A. Michaelson has a brief article entitled, "A Simple Interference Experiment," which physicists generally will read with profit. The difficulty of performing the experiment to show light interference has long been recognized by professonal skill, but we have a method now by the genius of Michaelson, that places this beautiful experiment easily within the reach of unskilled persons who may, by his method, obtain excellent results. This is quite important when one remembers that the Fresnel mirror experiment is the incontestible proof of the wave theory of light.

In *Monthly Notices* for January, Professor Holden publishes an article on the photographic apparatus of the great Lick equatorial. This istrument is now provided with a compound slide-rest as a means of moving the photographic plate in order to keep the star images "fairly round." Photographs can be taken on the scale of one minute of arc to sixteen-hundredths of an inch. Mr. Barnard has made positive enlargements of lunar photographs which show the moon twice as large as at the principal focus. Some features of these enlargements bear examination with a high power, making it possible for the astronomer to study the lunar surface at his leisure with a power of more than eleven hundred diameters.

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In Charles B. Hill's lecture before the Cosmos Club of San Jose may be found an interesting historical sketch of astronomical photography. Mr. Hill goes back fifty years in the record of photographic effort in astronomical lines, and traces its history to the present time. Speaking of lunar photography he says: "To photograph even the moon, it was formerly necessary to make an exposure of, say half an hour. The modern dry plate is so much more sensitive that better and sharper pictures are now made in one fiftieth of a second." The results of photographic work are discussed under the following heads: Photographs of the Sun, Transit of Venus, Total Solar Eclipse, Stars and Nebulae, and Star Maps.

Jonathan Young Scammon of Chicago died March 17, 1890, at the age of nearly 78 years. He was the father of the Chicago Astronomical Society and as such his memory rightly finds place in the permanent records of science in this country. He was the President of the Chicago Astronomical Society from its formation till the time of his death, except from 1882 to 1889, being re-elected a year ago after that interregnum.

Mr. Scammon was a lawyer by profession, and was recognized by all who knew him as a man of ability, and as a lover of science, especially astronomy. He paid for the building of the great tower on which the $18\frac{3}{4}$-inch telescope of the Astronomical Society, was placed. It cost $30,000. He also paid the salary of the director of the Observatory up to the time of the Chicago fire in 1871, and some payments after that date. His services in this noble work were great and are justly an enduring monument to his praise.

Refinements of Modern Instruments. We have received a copy of an address delivered before the Engineer's Society of Western Pennsylvania on the theme: "The Refinements of Modern Instruments and Manipulation," at a recent meeting of the society.

We ought to give our readers an abstract of this valuable paper at least, for it contains much useful information, in regard to mechanical errors in several different astronomical instruments. We promise to do this at an early date, if we do not find space for the whole paper.

Annals of Harvard College Observartory. Part 1, Vol. 21 of the Annals of Harvard College Observatory, and also Vol. 22, are received. The first is the Observations of the New England Meteorological Society in the year 1888, of uniform size of the publications of Harvard College Observatory and containing 105 pages of tables, descriptive matter and twelve charts representing the positions of observing stations, and monthly precipitations.

Vol. 22 contains the meteorological observations made at the summit of Pike's Peak, Colorado, from June, 1874, to June, 1888. Latitude of position, 38° 50′; longitude, 105° 2′ W.; height, 14,134 feet. These observations were made under the direction of the chief signal officer. The main object in this work, on the part of Harvard College Observatory, was to inquire into the meteorological character of stations of great elevation for astronomical observations before undertaking them. It will be remembered that the Boyden Fund, so-called, was established for prosecuting astronomical observations at some station at great elevation above sea-level.

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"*The Chief Discoverers of Comets.*" Under this caption in the March number of THE SIDEREAL MESSENGER is copied from the November number of the *Observatory* a table prepared by Mr. Denning, which contains a few errors, mainly caused by crediting some of the discoverers with comets already known and even expected. Rejecting these, the list, in the order of numbers, stands as follows:

Pons	26
Messrs. Tempel and Barnard, each	13
Brooks	12
Winnecke	9
Mechain and Swift, each	8
Klinkerfues and Borrelly, each	6
Bruhns, DeVico, Brorsen, Donati, Coggia, and Miss Herschel, each	5

This is perhaps a matter of no great consequence, save to the discoverers themselves, who desire to ascertain exactly their standing in this competitive work.

LEWIS SWIFT.

Warner Observatory, March 5, 1890.

Vol. II of the Publications of the Astronomical Society of the Pacific is a neat pamphlet of 39 pages. It contains a note on the densities of the planets by Daniel Kirkwood, an article by James E. Keeler, on a new and simple form of electric control for equatorial driving clocks, Arina O. Leuschner's article on the determination of the relation between the exposure-time and the consequent blackening of a photographic film, and number of other brief articles by Professor Holden and other members of the staff of Lick Observatory.

By kindness of F. Folie, Director of the Royal Observatory at Brussels, ws have notice of the death of the well-known Astronomer Charles Jean-Baptiste Fievez who was corresponding member of the Royal Academie of Belgium, and astronomer at the Royal Observatory of Brussels. His death occured February 2, 1890.

The Sun-Spots and La Grippe. In the Chicago *Tribune* of Jan. 13, 1890, is an illustrated article under the above title by J. H. Kedzie of Chicago. In it is a comparative table showing the numbers of sun-spots by months for each of the years 1887, 1888 an 1889, also two illustrations of spots, one by Professor Langley, and one from Professor Young's book entitled The Sun. Reference is made in the article to the belief of intelligent men, of a relation between the prevalence of sun-spots and the condition of crops, prices, stocks, peace or war, and public health, including the widespread influenza known as La Grippe.

The difficulty that the careful scientist finds in the study of such relations as these is that mere coincidences are not proofs. They only raise a presumption in favor of the assumed cause after a great number of concurring coincidences have been observed. Writers should be careful how they use the principle of induction to establish a relation between sun-spots and disease prevalence, or commercial or political affairs, lest they lead the uninformed into gross errors.

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Telescopes for Sale. It may be of interest to our readers to know of the following telescopes for sale:

1. A 4-inch equatorial telescope nearly new; portable mounting; cheap. George Turnham, Meredosia, Ill.
2. A 3-inch astronomical telescope; powers 34 to 64; Tripod mounting. Jacob M. Clark, C. E., 145 Madison Avenue, Elizabeth, N. J.
3. A 5½-inch refracting telescope; circles; driving clock; iron pillar; prism and 5 eye-pieces. Henry Harrison, 14 and 16 Astor Place, New York City.
4. A 5⅛-inch objective in cell, with battery of eye-pieces; also
   A 2-inch transit instrument in brass pillar; good condition. Daniel Appel, 11 Holyoke Place, Cleveland, Ohio.

Telescopes Wanted. E. P. Frost, Glencoe, Minn., wants a second hand instrument, 6-inch aperture.

J. B. Craton, Council Grove, Kansas, wants a 3 or 4-inch instrument.

U. V. Lawton, Jackson, Mich., wants a good second-hand 4-inch equatorial telescope.

BOOK NOTICES.

FAMILIAR TALKS ON ASTRONOMY, with Chapters on Geography and Navigation. By William Harwar Parker, Author of "Recollections of a Naval Officer," etc., Chicago. Messrs. A. C. McClurg & Co., publishers; 1889; pp. 264. Price $1.

As the title implies, the design of this book is to present the general facts of Astronomy in plain language, and in a more attractive form for the general readers, than that commonly used in the ordinary text-book. These instructive talks are such as a well-informed teacher might give a class of students who have some knowledge of the elements of Astronomy, and who are eager to know more of this delightful branch of study, especially if the instructor will confine himself to the general facts of the science and avoid its *minutiæ* and its techincalities.

On this plan the book gives fourteen talks. The first begins by showing the necessity of *thought* and *meditation* if the student expects to realize much by giving his attention to the reading or study of Astronomy. In this connection the author aptly quotes the sayings of some eminent thinkers while he is talking about reading and thinking. These are examples: Carlyle says: "A man gathers wisdom only from his own sincere exertions and reflections." Paschal says: "All our dignity consists in thought." Gibbon, "The use of our reading is to aid us in thinking." Jefferson, Madison, and Adams were thinking men. When we read their productions we are struck with the originality of their thought. It is true, as Rousseau said: "Naturally man *thinks* but little," but it is also true that "a very small lot of books will serve to nourish a man's mind if he handles them well; and I have known innumerable people whose minds have gone all to ruin by reading carelessly too many books."

This is certainly a fitting introduction, and if the reader heeds it faithfully he will be profited in reading this book.

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In the remainder of this first talk the author defines astronomy; speaks of its language; presents the solar system; something of the way ancient astronomers observed; how time is reckoned and the calendar made; of the progress of astronomy, and how the size, shape and motions of the earth are determined. Talks two and three are upon the change of seasons, the obliquity of the ecliptic, the apparent motion of the sun, and the phenomena attending the motion of the earth in its orbit. Talks four and five are in reference to the moon, in which earth-shine, the moon's revolution, and finding the moon's age are noteworthy. Under the last head the author rightly refers to some of the surprising statements of our best English and American writers like the following: Shortly after the sun went down the crescent moon appeared in the east." Dickens in Barnaby Rudge says: "It was a fine dry night, and the light of the young moon, which was then rising, shed around that peace and tranquility which gives to *evening time* its most delicious charm." Captain Maryatt speaks of a *crescent-shaped* and *waning* moon being seen early in the evening. Talks six and seven deal with the sun, noticing its dimensions, its physical characteristics and eclipses. Talk eight is about the planets, and talk nine is a continuation of the same with such added themes as the velocity of light, seasons on other planets, determination of the density and mass of the earth. Talk tenth is about the stars, talk eleventh, time, and talk twelfth is concerning a universal system of time. Talks thirteen and fourteen are upon Nautical Astronomy in which the author has had years of practical experience, and concerning which he speaks so clearly and well that they form an interesting and valuable portion of this book. The publishers' part of this work is neatly done.

THE SCENERY OF THE HEAVENS; A Popular Account of Astronomical Wonders. By J. E. Gore, F. R. A. S., M. R. I. A. With Stellar Photographs and other Drawings. London: Messrs. Roper and Drowley, publishers, 11 Ludgate Hill, E. C. 1890. pp. 320; price, 10s 6*d*.

The subject matter of this new book is divided into two parts; the first describing the solar system, and the second the sidereal heavens; the first part is given in seven chapters which present the following topics in order: The Sun, The Moon, The Planets, Comets, Shooting Stars and Meteorites.

The order of the topics in the second part is: Number and Magnitude of the Stars, Double and Binary Stars, Nebulæ and Clusters, Variable and Temporary Stars, The Milky Way and the Visible Universe, and The Astronomy of the Poets. Then follows tables of the Positions of Red Stars, Positions of Binary Stars, and Positions of Variable and Temporary Stars.

The design of this work is to give a popular but exact account of the most interesting facts relating to the planets, comets, meteors, fixed stars and nebulæ, without technical language or the use of mathematical formulæ. The sun is the theme of the first chapter, and the wonderful facts of its size, distance, and attractive power are illustrated in a great variety of ways, some of which are apt and unique, and all are useful and good. The brief description of its physical constitution represents the best and latest views of specialists in this line of study.

The moon is next considered in regard to surface delineation, and a fine

drawing of the lunar walled crater, Plato, by T. C. Elger, 1887, appears in connection with chosen details for study. A single page on the phenomena of a total lunar eclipse, in which the black and bright eclipses are referred to, is very suggestive in regard to matter of fact. No attempt is made to explain the so-called black eclipses. Remarks on the inferior planets are brief, but to the point. An example of this is found under Venus, where the author is speaking of that planet as a morning star, about Christmas time, when it is mistaken for the so-called "Star of Bethlehem," by intelligent and well-read people (except in elementary astronomy). We quote a few words: "Whatever the star of the Magi was, one thing is certain, it was not Venus. It seems, indeed, absurd to suppose that the "wise men" of the East should have mistaken a familiar object, like the planet Venus, for a strange apparition. That it was familiar to the ancients we know from the fact that an observation of the planet is found on the Ninevah tablets of date B. C. 684, and it is also mentioned by Hesiod, Homer, Virgil, Martial and Pliny. Indeed it seems impossible to suppose that so conspicuous an object should remain unnoticed for any length of time."

Under the head of superior planets, the author speaks of the force of gravitation on the planet Mars, and in consequence, the possible giant size of its people, the wonderful canals recently discovered there, and the views of prominent observers concerning this phenomenon, the polar snow caps, the ruddy color of its land surface, its two minute satellites, and some of the curious physical facts in consequence of the small mass of each of them.

Such trains of thought as these are to be found in connection with the various topics before named, and the spirit of the whole book is admirable, because it recognizes Almighty God as the Creator of All this wonderful work, and gives credit to Him as its Author. We think this is a better way to do than to attempt to glorify what any man may have done in finding out the thoughts of the Creator that probably have waited many ages for the appearance of a human mind that was large enough or natural enough in its powers to perceive them and to understand them.

We have read this book with special interest, and welcome it to a place in our general library.

ELEMENTARY LESSONS IN ASTRONOMY. By J. Norman Lockyer, F. R. S. London: Messrs. Mcmillan & Co., and New York. 1889, 8vo, pp. 363. Price, $1.25.

This book is a new edition of a work bearing the same title that was first published in 1868. It is not to be confounded with the Elements of Astronomy by the same author, which probably has been more commonly used in this country than the book now before us. This revision has the same general appearance as the earlier ones, is somewhat increased in size, and quite largely re-written, having several new cuts, and facts generally brought to date. In the earlier portion of this book Mr. Lockyer makes references to the conclusions which he has reached quite recently in regard to the constitution of the heavenly bodies. These views have been widely published in this country and in Europe, and certainly do not now need further comment. The last edition is materially improved, and is a credit to its distinguished author.

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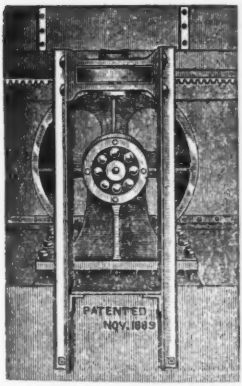

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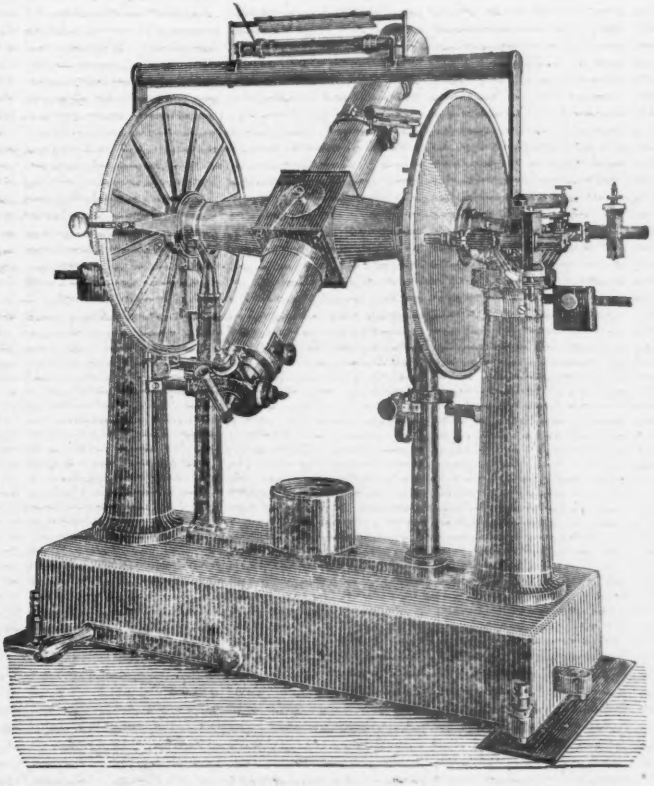

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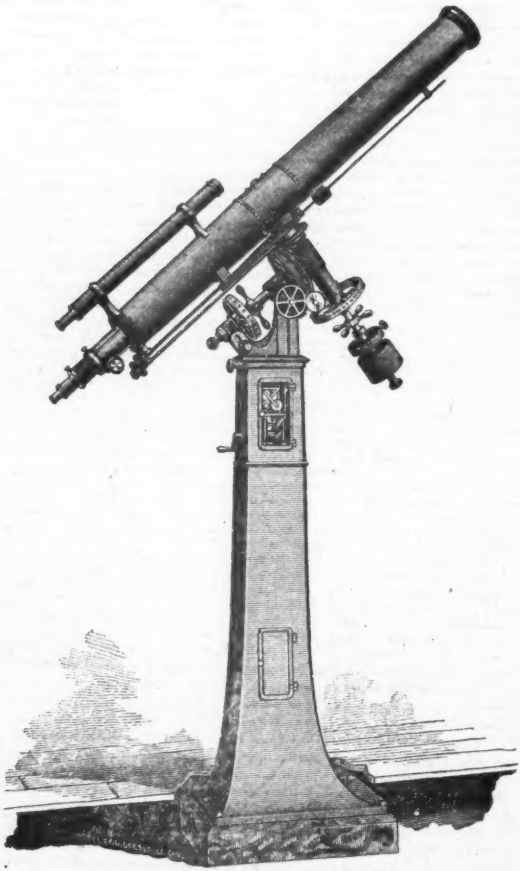

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